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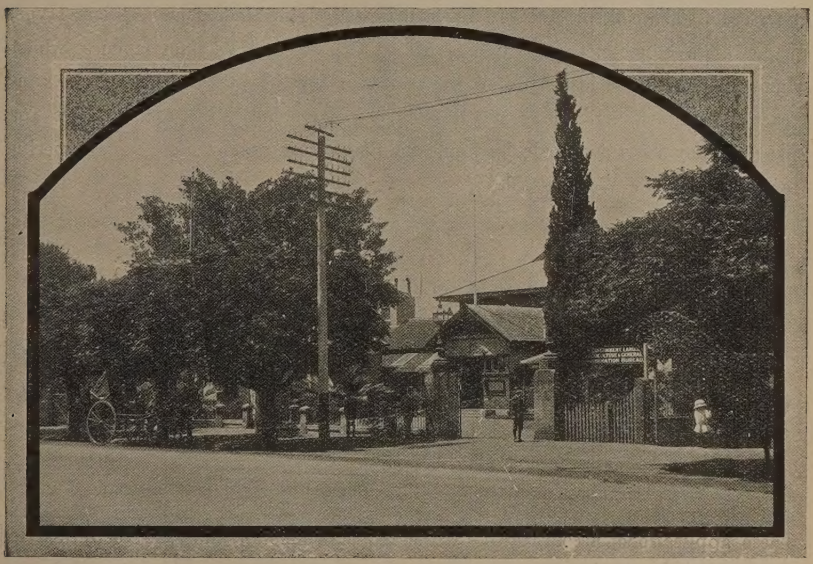

OUR HOME.

To residents of Perth, and to many who live in the country districts, the old building in which the Department of Agriculture is housed is a familiar site. If walls could speak, of what a wonderful progress they could tell, for the history of Western Australia has been discussed and reviewed, prophecies uttered, memories and experiences exchanged, and congratulations and condolences iterated and reiterated. Laws have been made and confirmed, bills debated, science discussed and new announcements made, while policies pregnant with importance to

the country have been framed and perfected within its precincts. Antiquated in appearance, it still keeps in the van of modern practice, and its venerable look belies the energy and enthusiasm within.

It is interesting to trace its history, for it will soon have reached the fine old patriarchal stage of the centenarian. Culled from some early archives supplied by the State Archives Board are the following particulars:—

The specifications for the building of the public offices in Perth, on St. George's Terrace, opposite the officers' quarters and 30 feet back from the South boundary of the street, were adopted and the contract signed on the 17th October, 1836, the accepted contract being priced at £1,833 15s. 6d. A condition was that it should be completed 15 calendar months from the date of contract, but the last payment (for painting) was not made until some two years later, on 16th February, 1839. The contractors were Edward Powell, John Melbourne, William Hyde, jun., James Minchin, George Green, Alfred Carson, and William Holmes, whilst James Stokes and Richard Jones were sureties for the performance of the contract. Designed by Henry W. Reveley, Civil Engineer, the earlier notes for progress payments are made by him, and those later are by H. Trigg, Superintendent of Public Works.—Ed.

"THE JOURNAL OF AGRICULTURE"

will be supplied free *on application* to any person in the State who is following Agricultural, Horticultural, or Viticultural pursuits, to Agricultural Societies or Associations, and to any person otherwise interested in Agriculture.

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The current list of recipients will be revised after the December issue this year, and all who desire continuance, or renewal, are requested to notify the Director of Agriculture, otherwise their names will be removed therefrom.

HORTICULTURAL NOTES.

Geo. W. Wickens,

Superintendent of Horticulture.

Each year, generally in August, and never later than September, inquiries regarding the fruit crop expected in the coming season start arriving at this office, and from then onwards the number of inquiries increase in volume until the final estimate is made some time in December. As the main anxiety of most of those who require the information is in connection with the quantity available for export, the principal interest centres in the apple crop, this being the one that figures most largely in the overseas trade from Western Australia, and frequently uncomplimentary remarks are made concerning the officers of the Department, who will not publish an estimate before December, but estimates to be of any value must have a reasonable chance of being somewhere near final results, and those who have earned a livelihood by growing fruit know to their discomfiture the number of unpleasant things that can occur between the "spur-burst" stage of the apple buds in September, and the "set" fruit in December.

From our experience this year, one cannot but think that in spite of all the best of growers can, and did, accomplish, in the way of preparing the trees to bear abundantly, their efforts would have been of no avail but for a hefty lump of good luck. Thrips, which have devastated the orchards of our fruit growing friends in the Eastern States, arrived here just a few days too late to perform a similar act of destruction in Western Australia. It was so close that I must confess to a "goose-fleshy" feeling when I think of it, and I have no doubt there are many others in the industry who experience a catch in the breath when they contemplate what might have happened.

However, that hurdle has been safely negotiated, and no other obstacle having arisen up to date to prevent the trees from functioning as satisfactory producers, I will make a forecast that I believe will not be far astray when the actual returns are known in October next after the bulk of the fruit has been sold.

The average apple crop for the past five seasons, 1927 to 1931 inclusive, has amounted, in round figures, to 725,000 bushels per annum, the highest yield in that period being in 1929 with 1,122,000 bushels and the lowest in 1928 with 409,000. In December of last year I estimated the apple crop for 1931 at a minimum of 800,000 bushels, but results proved I was over-sanguine as the crop did not quite reach 750,000, though there is no doubt the long dry summer and failure of a lot of fruits to reach normal size accounted for most of the shortage.

My estimate for 1932 is 760,000 bushels. I consider this a conservative one, but I am influenced by the fact that the crop in the Mount Barker-Albany district is very heavy (the heaviest in my opinion ever produced in that part of the State), and if this summer proves as dry as last the fruit may be small. In addition to this, the crop in the Bunbury-Pemberton section is comprised largely of "Cleopatras," which may develop "cork" to some extent and thus reduce the quantity available for sale. In the Southern district, Mount Barker-Albany, practically all varieties, excepting "Romes," are fruiting heavily; in the South-West, Bunbury-Pemberton, "Cleopatras" and "Yates" are heavy, "Grannys" about half a crop, "Jonathans" light, with a tendency to bunched fruits on terminals, "Dunns" nearly a failure, mainly on account of last season's over-crop; "Romes" and "Nickajacks" also nearly a failure, but in this instance thrip was the destroying agent.

Pears, from time of blooming to present date, have had a varied experience; in several orchards frost destroyed the "Bartlett" crop, and in all places the ordinary shedding of young fruits of all varieties has been more than usually severe. Still, allowing there will be less "Bartletts" this season, the crop as a whole will be heavier than last, particularly export varieties—"Josephine," "Winter Nelis," "Comice," and "Beurre Bosc." The pear crop over the past five years has, in round figures, averaged annually 89,000 bushels, and my estimate for this season is 90,000.

Early attempts at forecasting the stone fruit crop went woefully astray, because the comparatively light crop of last season made it reasonable to assume a heavy crop would be harvested this season, but severe frosts as late as the 16th October, and cold showery weather in September, upset all prophecies, and the stone fruit crop as a whole will, I think, be lighter even than last year. "Early Newcastle" apricots have fruited heavily, but all late varieties are on the light side. Japanese plums are much lighter than last year, particularly "Satsuma," which, in many orchards, is a failure. English plums are not largely grown in Western Australia, but the crop of these is about equal to last season. Peaches and nectarines also are about the same as last year.

To summarise:—

PIP AND STONE FRUITS.

Kind of Fruit.	Production for season 1930–31.	Estimated production for season 1931–32.
	cases.	cases.
Apples	749,449 ...	760,000
Pears	80,684 ...	90,000
Peaches	50,223 ...	50,000
Nectarines	11,469 ...	11,000
Apricots	43,840 ...	40,000
Plums	57,956 ...	45,000

The grape crop will be about the same as last season, with the exception of sultanas, which are heavier. Last season the production of fresh grapes amounted to 56,699 cwts. of table grapes; 50,133 cwts. of wine grapes; and 190,883 cwts. of grapes grown for drying purposes, making a total of 297,715 cwts. As stated above, it is estimated that the production in season 1931-32 will nearly correspond with that of 1930-31.

It is yet too early to make any estimate of the citrus crop.

We are, at time of writing, within a fortnight of Christmas, so I shall take this opportunity of wishing all readers of these notes a Merry Christmas, a Happy New Year, and an export season free from complaints about "water core breakdown."

BUFFALO FLY.

Measures adopted for the prevention of the spread of the Buffalo Fly (Lyperosia Exigua) from the Kimberley District to the South-Western portion of Western Australia.

By C. R. Toop, B.V.Sc., Government Veterinary Surgeon, Derby, W.A.

The Buffalo Fly has long been regarded as a pest inimical to the interests of pastoralists engaged in the cattle-raising industry in Northern Australia. Since its introduction into Darwin about the year 1828, where for reasons apparently not well understood it remained more or less localised for a considerable period, it has spread in ever-widening waves until at the present time the pastoral areas of Northern Queensland are threatened by invasion, while in this State almost the whole of the cattle-raising areas of both East and West Kimberley have become involved; the southernmost limit of infestation at present being defined by the 20th parallel of latitude. Extension has been very rapid during recent years, possibly on account of the fly having more fully adapted itself to environment and climatic conditions. Some conception of the rapidity of its spread in North-Western Australia may be gained from the fact that, in November, 1928, an investigation of the position revealed the fly not to be in evidence further south than the 18.30° parallel of latitude, whereas when a further investigation was made in March of the year 1931, the fly was detected almost as far south as the 20th parallel. It is estimated that during this interim the fly had advanced in its forward march a distance approximating one hundred miles.

As the Buffalo Fly, its life history and habits, have been fully investigated and described by others, it is intended only to mention this subject briefly in passing, and then only for the purpose of providing a clearer understanding of the motives which actuated this Department in the initiation of measures calculated to prevent its extension from the Kimberley district to the south-west portion of the State, and, further, that the significance of any such measures might the more fully be recognised.

The Buffalo Fly is essentially a parasite of bovines, though other animals such as donkeys (particularly), mules, and horses may sometimes be attacked. When the life history of the fly is considered it will be seen that the infestation of these latter animals is more or less of an accidental nature.

The fly is a relatively small greyish insect, scarcely more than half the size of the common house fly (*Musca domestica*). When poised, it appears broadly triangular in shape, the apex being formed by the head and thorax which are comparatively small in proportion to the wing span. It is very tenacious of life. When grasped between the thumb and forefinger it is quite resilient to the touch, giving one the impression of handling a small piece of india rubber. When released after considerable pressure, it escapes and is able to fly with activity unimpaired.

The Buffalo Fly is a biting blood-sucking insect adhering closely to its host to which it remains attached both night and day. If disturbed it rises rapidly but just as rapidly descends upon its host.

Under natural conditions its favourite sites of attachment are the following:— Behind the poll and base of horns, the withers, the lumbar region of the back, and low down on the flanks and ribs towards the abdomen. When infestation is gross flies may be observed adhering in clusters to these areas; they having obviously

been selected on account of their comparative inaccessibility to the disturbing influence of the tail of the beast. All other portions of the body are, of course, subjected to attack but upon these flies are never observed in such large numbers.

The Buffalo Fly breeds in bovine manure. The eggs are deposited by the female upon the surface and in the crevices of fresh faeces, and after hatching the usual cycle of larva to pupa to adult fly is undergone. According to Murnane's observations the whole life cycle from egg to adult may occupy a period of only nine days when conditions are favourable to propagation. Multiplication under such conditions may therefore occur very rapidly.

Seasonal Incidence.—The Buffalo Fly has a seasonal incidence, its numbers increasing enormously after the onset of the wet season which, in North Australia, usually extends from December to April. By the end of the wet season and for a short period thereafter, flies are usually present in very great numbers. With the onset of cooler weather conditions and drying easterly winds towards the middle or end of May a gradual diminution of numbers occurs until by the end of June a minimum of usually very light infestation is reached. Although a sharp rise and a progressive increase in temperature occurs from August onwards to November, this minimum of infestation persists and no appreciable increase in numbers occurs until wet weather conditions again make their appearance. Both temperature and humidity play an important rôle in the propagation of the Buffalo Fly: the one appearing no less important than the other in this respect.

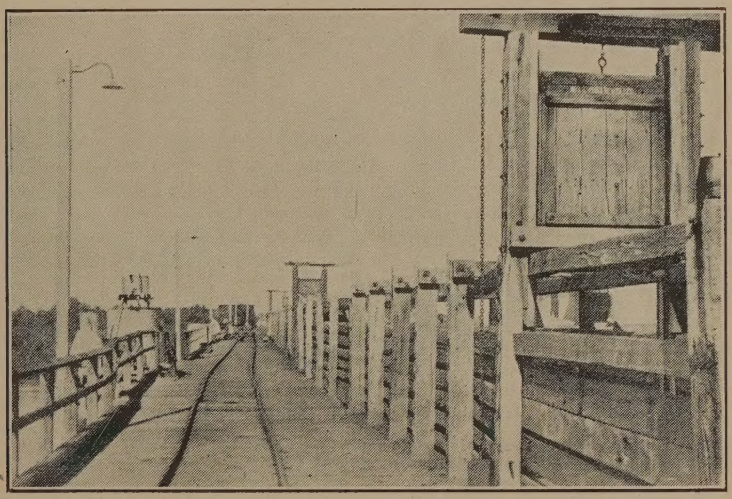
Seasonal Variation.—In addition to a seasonal incidence there is a seasonal variation. In extremely dry seasons an apparently entire disappearance has been observed to occur by the end of June even on coastal areas, whereas in wetter seasons considerable infestation has been noticed to persist on such areas throughout the year. In the West Kimberley district the Buffalo Fly is to be regarded almost essentially as a coastal pest, the humidity factor playing an important part in this connection. Infestation at all periods is invariably lighter on inland areas and the disappearance of the fly therefrom usually synchronises with, or at all events, follows close upon the termination of the rainy season.

Coastal infestation is itself subject to considerable variation, *e.g.*, in the Broome district where heavy dews occur throughout the year flies are invariably to be observed in quite considerable numbers. In the Derby district, on the other hand, where no such dews are recorded infestation has been noticed to have almost, if not entirely, subsided during the winter months. It is doubtful, however, whether in any season the inhibitory influences of comparative cold and dry atmospheric conditions are at any time capable of bringing about an absolute disappearance.

Effects of Infestation.—Cattle hitherto clean have been observed to exhibit intense "fly worry" when suddenly exposed to heavy infestation. This is evinced by restlessness, almost constant tossing of the head and switching of the tail. This condition has not infrequently been observed amongst dairy cows in the township of Derby which have become infested on the arrival of station cattle for shipment at that port. On the other hand, cattle bred on infested country and those which for a period have been accustomed to heavy infestation appear to acquire a very definite tolerance towards the fly. Amongst such cattle there is little evidence of "fly worry" apparent, though they do exhibit some uneasiness when infestation is gross. The fly nevertheless exacts its toll in the quantity of blood that is drawn in feeding. When flies are present in countless thousands as they frequently are, this must be very considerable, and is doubtless accompanied by a loss of condition. What condition is lost by this means it is not possible to estimate. Furthermore,

the irritation caused by the fly and the endeavours of the beast to allay such irritatioin by rubbing against objects such as trees and ant beds is sometimes responsible for the formation of raw, abraded granulating wounds, chiefly to be noticed beneath the jowl and along the dewlap. These wounds may be up to two inches in diameter and are rather slow in healing. A similar condition is at times noticed at the medial canthus of the eye in unpigmented Hereford cattle. I do not know that colour plays a very important part with regard to infestation—perhaps dark-coloured beasts are more frequently selected by the fly—but it is certain that fine-haired, smooth-coated animals are more frequently the subject of attack than "soft" long-haired beasts. When infestation is heavy, however, neither of these factors are of much importance.

The redeeming feature, if such it may be termed, with regard to Buffalo Fly infestation in North-West Australia is its seasonal incidence. As previously stated, the peak of infestation is reached and maintained during and for a short period after the termination of the rainy season. Then pastures are green and luxuraint, cattle are strong and in good condition and are well able to withstand the attacks of the fly, suffering little apparent detriment. During the dry season which extends from May to December, and particularly towards the latter, and when cattle, especially breeders and young stock, are struggling for an existence under the severe conditions of partial drought which invariably prevail annually in the Kimberleys, infestation sinks to a minimum and the much weakened animals are, fortunately,



The Cattle Race, Derby Jetty, and Spraying Plant.

little troubled by the pest. For this reason the Buffalo Fly is to be regarded as an animal parasite, as of secondary importance to the cattle tick (*Boophilus Australis*). In the latter case the highest degree of infestation is frequently reached when the condition of the aminal, and its vitality, are at their lowest ebb.

Having regard to the habits of the fly, *i.e.*, its continuous attachment to its host as well as its apparent tenacity of life, it was early recognised that this pest might easily be transported to Fremantle with cattle shipped from Derby and Broome. By such means a gap of sixteen hundred miles might have been

bridged in the space of a few days of travel, and a pest at present confined to tropical North Australia might have been thus introduced into the dairying areas of the South-Western portion of the State. Attention was drawn to this possibility by Murnane in 1926 and by myself in 1928. Evidence available up to that time had shown that while flies did accompany the cattle on to the ship at the time of loading both at Derby and at Broome, a total disappearance occurred when colder weather conditions were encountered upon rounding the North-West Cape. It was not until the year 1929, however, that the Buffalo Fly was actually observed to reach Fremantle on North-West cattle boats. This occurred amongst a consignment of cattle shipped from Broome in March of that year. During that period of the year warm weather condition would prevail during the whole of the southward voyage.

With the fly at Fremantle, and, so to speak, at the very back door of the dairying industry, the position was regarded as a serious one, calling for immediate action. The need was further emphasised by the result of experiments subsequently carried out by Mr. L. E. Newman, the Entomologist of the Department of Agriculture, who succeeded in breeding out in the laboratory at Perth a local generation of flies from flies captured on a North-West cattle boat:—

On April 27th, 1929, these flies were placed in the insectary and provided with fresh bovine faeces upon which they deposited eggs. On May 27th—one month later—several Buffalo Flies emerged. The maximum temperature on the day of emergence was 63 deg. F., the minimum on the previous night having been 52 deg. F. These survived for six days without food, being exposed in a glass jar to night temperatures. During this period the minimum temperature recorded was 46 deg. F, and the maximum 70 deg. F. The mean minimum temperature for the period was 50 deg. F., and the mean maximum temperature 65 deg. F.

On May 28th a second lot of flies were captured and placed under identical conditions. Eggs were deposited on May 31st. On July 16th—forty-six days later—flies issued. The following temperatures were recorded during this period: Maximum 72.8 deg. F., minimum 338 deg. F., mean maximum 61.7 deg. F., mean minimum 47 deg. F. These experiments indicated that even under the mid-winter climatic conditions of Perth the fly was able to pass through its life stages without application of artificial heat.

The assumption that flies transported to Fremantle on North-West cattle might readily establish themselves amongst the dairy herds in the relatively mild environs of Perth and Fremantle, was not, therefore, an unreasonable one. Furthermore, it did not require a very far flight of the imagination to envisage a time when, by a process of gradual adaptation to changed environment, the pest would become firmly established in the less equable climatic conditions of the principal dairying areas of the State.

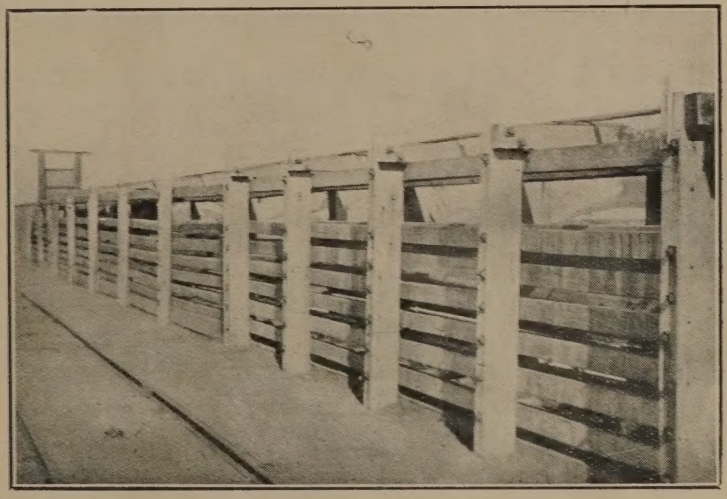
Recognising the seriousness of this menace it remained now to devise a means whereby the risk of such introduction might be obviated.

Spraying of the cattle on board ship with some lethal agent, subsequent to loading, was first mooted, but here there was an important factor to be reckoned with, *viz.*, the disposal of the manure accumulated during the southward voyage. This is a product of considerable value as a fertiliser to market gardeners in the Spearwood district. Considering the life history of the Buffalo Fly, *i.e.*, the fact that it breeds in bovine faeces, it was patent at the outset that in order to render the South-West absolutely safe against its introduction, such manure would of necessity have to be dumped at sea, which would exclude from release and distribution amongst the Spearwood growers a product of considerable value to them

commercially. It was, therefore, considered that the safest method that could be adopted would be the treatment of all cattle prior to embarkation at the northern port of shipment, for the purpose of ensuring that they would be free of infestation before departure from that port.

Two important points now presented themselves for elucidation, *viz.*:—(1) The determination by experiment of a substance which, when applied to infested cattle, would prove both lethal and repellent to the Buffalo Fly. It was further necessary that any such substance would prove non-injurious to the host, and that its cost would be such as would render its use practicable from an economic aspect.

(2) A mechanical means whereby such substance might be applied expeditiously and efficaciously to the cattle. In the latter connection it had to be remembered that cattle were being shipped in consignments, the numbers of which ranged from 320 to 760 head, and that owing to the vagaries of the tides in their influence upon shipping the maximum time available for loading did not exceed six hours.



The Cattle Race, Derby Jetty.

The project of treating the cattle in the loading race by means of a shower spray was carefully considered, its practicability tested out, and plans embodying the requirements of such a spray submitted to the Chief Veterinary Officer. These plans were elaborated by Mr. Golding, Acting Controller of Abattoirs, and a plant as outlined constructed. After carrying out preliminary trials upon cattle at Midland Junction which were accompanied by satisfactory results, the plant was consigned to Derby, installed and successfully operated in July of 1929. Since that date it has always been employed during the loading of cattle. With the passage of time and the acquisition of additional knowledge of the requirements for maximum efficiency, many improvements have been effected, but the plant as it stands at present is the same in principle as the one which was originally constructed.

In the meantime, in collaboration with the Entomological Branch, experiments for the determination of a substance lethal and repellent to the Buffalo Fly and

suitable for spraying purposes were being carried out. Preliminary experiments were performed in the laboratory at Perth, and those substances, which it was considered might prove effective, were consigned to Derby for actual testing against the Buffalo Fly. These experiments have been in progress during the past three seasons. The methods adopted are simple and are as follows:—

(1) The spraying of infested cattle with the substance under test by means of a hand pump fitted with a Bordeaux nozzle and capable of producing a fairly heavy spray.

(2) The spraying with the substance under test of flies imprisoned within gauze containers. For this purpose, flies are released from the catching net into wide-mouthed mason jars from which they are liberated into cylindrical wire gauze receptacles. The spray is applied in atomised form through the meshes of the gauze by means of a small pump.

While results secured by these methods could not be regarded as absolutely conclusive, they, nevertheless, served to provide fairly accurate information as to how these substances would behave when employed in the shower spray in the loading race.

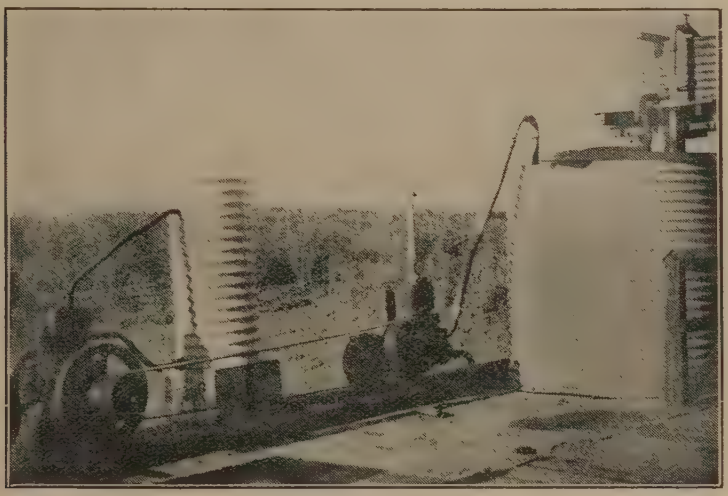
The results secured with the various substances experimented upon are set out hereunder in tabulated form. Though somewhat incompletely presented, this will serve to show the relative efficacy of the various materials submitted to test. The cost per 100 gallons of mixed solution, *i.e.*, the strength in which it is intended for use, which is of cardinal importance from an economic point of view, is included. No computation of cost has been made in the case of those substances which on experiment proved ineffectual; this, in the circumstances, appearing unwarranted.

Substance.	Dilution with Water.	Lethal Action.	Repellant Action.	Effect on Animal.	Approximate Cost inclusive of freight per 100 gallons Mixed Solution.
Phenyle ...	1 in 25 ...	None	Transient when animal wet	None	Not computed.
Kerosene Emulsion	1 in 40 ...	do.	do.	do. ...	do.
Flytox	Concentrated	Immediate	Immediate ...	do.	£90.
Ping	do.	do.	do. ...	do.	£90.
Izal	1 in 125 ...	None	Transient when animal wet	do.	Not computed.
Pyrethrum Powder, 18½lb. ... Izal, 1 gallon ...	Water, 125 gallons	do.	None ...	do.	do.
Vacuum Spray Oil	1 in 40, 1 in 60	Slowly lethal on contact	do. ...	do.	do.
Clensel	1 in 25 ...	Rapid disabling effect. Moderately lethal on Contact	Transient when animal wet	do. ...	£2 1s. 9d.
Clensel	1 in 15 ...	Immediate disabling effect. Rapidly lethal on Contact	do.	do.	£3 7s. 9d.
Bedwell's Fly Blow Oil	1 in 40, 1 in 50, 1 in 60	Immediate disabling effect. Rapidly lethal on Contact	do. ...	do.	17s. 6d. (1 in 60 dilution).
Carbolicide ...	1 in 20 ...	Immediate disabling effect. Very rapidly lethal on Contact	do.	Slightly irritant to conjunctival Mucosa	16s.
Carbolicide ...	1 in 16 ...	Immediate disabling effect. Very rapidly lethal Contact	do.	do.	20s.
Benzophen ...	1 in 40 ...	Identical with Carbolicide, 1 in 20	... ...	... ...	13s.
Benzophen ...	1 in 32 ...	Identical with Carbolicide, 1 in 16	... ...	... ...	15s.
Form-o-leen ...	1 in 40 ...	Moderate disabling effect. Lethal on Contact	Transient ...	Irritant to Mucous Membrane	Not computed.

From the foregoing it will be observed that the proprietary mixtures "fly tox" and "ping" were the most efficacious of the substances tested out. The cost of these materials was prohibitive, and it was at once obvious that they could not be considered for use in the treatment of large numbers of cattle.

Clensel in a dilution of 1 in 25 with water was found to be possessed of a disabling effect which was rapidly produced. This was of a transient nature. After spraying infested cattle disabled flies were noticed crawling on the ground beneath. When kept under observation it was noticed that after a short period the ability to fly was recovered and the flies arose with unaffected vigour. Flies were killed fairly rapidly on being contacted with this material, and after thorough wetting no recoveries occurred. After the inauguration of spraying operations at Derby, Clensel 1 in 25 was employed for a considerable period with satisfactory results, an efficiency estimated as up to 99 per cent. being secured where flies were numerous, and in cases where infestation was not so heavy no flies appeared to survive.

Clensel in the more concentrated dilution of 1 in 15 appeared considerably more effective both as a disabling and lethal agent, but the economic factor of relatively high cost precluded its use in the spraying plant.



Spraying Outfit.

Bedwell's Fly Blow Oil in the respective dilutions of 1 in 40, 1 in 50, and 1 in 60 with water on experiment gave encouraging results. There appeared to be no appreciable difference in action with any of these dilutions. The disabling action, though transient in nature, was immediately produced. It was rapidly lethal to the fly on making thorough contact. Flies so contacted did not recover.

Following upon the results secured by experiment, Bedwell's oil in the strength of 1 in 60 was used in the spraying plant as a substitute for clensel 1 in 25; a high degree of efficiency resulting, it being estimated that even when infestation was gross such efficiency fell considerably less than one per cent. below the maximum possible to secure, *i.e.*, the destruction of all flies. With less heavy infestation 100 per cent. of efficiency appears always to have been secured. More detailed reference to the results of spraying is later made.

It will be seen that from the view point of cost this material was more attractive than clensel, and moreover it was produced within Australia, whereas the latter product was of foreign origin.

Carbolicide in the dilutions 1 in 16 and 1 in 20, produced an immediate but transient disabling action. Both were very rapidly lethal on making contact with the fly, appearing considerably more so in this respect than Bedwell's oil. Of the two the 1 in 16 dilution appeared the more efficacious.

Benzophen in the respective dilutions 1 in 32 and 1 in 40 gave results which were identical with those obtained with carbolicide in the dilutions mentioned above. Benzophen is merely a modification of the substance carbolicide. Following upon our representations to the manufacturers to increase the concentration of the carbolicide supplied for the purpose of reducing high transport charges which apply on the north-west coast, its strength was doubled, the new product for purposes of differentiation being designated Benzophen.

The use of Benzophen 1 in 40 in the spraying plant at Derby has to date been attended by a maximum of effciency, apparently no flies having survived. As flies have not been present in large numbers since the commencement of its use, it has yet to withstand the test of gross and active infestation. Under such conditions satisfactory results are anticipated with the 1 in 32 dilution.

The cost of this substance is lower and its efficacy apparently higher than that of any other substance previously tested out whose use comes within the ambit of economic practicability.

Benzophen is known to possess a somewhat irritant action to the conjunctival mucsa, but this has been responsible for no delay in loading operations, nor has it proved of detriment to the cattle.

It will be seen that none of the substances which came under test were possessed of more than transient repellant properties, and these were only apparent while the animal was wet with solution. Such substances may be sufficiently nontropic to temporarily mask the attraction odour of the beast, but they are certainly not sufficiently negatively chemo-tropic to prove distasteful to the fly. It would, however, appear that in the treatment of cattle prior to shipment these repellent properties are of secondary importance. It is essential that no flies shall accompany the cattle after they have emerged from the spray, and to meet this requirement it is very necessary that the material employed shall possess markedly lethal properties. It does not appear that a repellent *per se* would prevent flies from following the cattle on to the ship. Though the possession of well marked and lasting repellent properties would doubtless enhance the efficacy of a substance, it is its lethal qualities that are the all-important ones.

In the problem of spraying solutions, it is recognised that there is still much scope for further research work. It would appear that the objective to be sought is the production of a substance of which the vapour or finely atomised spray will itself prove rapidly lethal to the fly.

The Spraying Plant described.—The shipping of cattle at Derby involves their passage through a long race extending from the stock yards at the one end, over the jetty to the ship's side at the other. The dimensions of this race are shown in the accompanying plans. It has a total length of approximately 990 feet. For spraying a section 120 feet in length is used within which cattle may be confined by drop gates Nos. 1 and 2. The distance from gate No. 1 to the ship's side measures approximately 270ft. and from gate No. 2 back to the stock yards 600ft. The spray itself consists of three lines of 1¼in. galvanised piping—one overhead

and two lateral—running the whole length of the section of 120ft. apportioned for spraying purposes. These pipes are fitted with jets spaced at three-foot intervals, the lateral pipes being set at 20ins. above floor level, and their jets directed upwards at an angle of 45deg. Solution is forced to the pipes by means of a Bulldozer pump driven by a 4½ h.p. Lister engine. The jets are capable of throwing a dense heavy spray which consumes on an average 2½ gallons of solution per beast treated. Solution is drawn from a storage tank of 1,000 gallons capacity. In addition there is a 100 gallon overhead auxiliary tank in which solution may be mixed and conveyed to the large tank by means of a pipe as its supplies become depleted. On account of the difficulty of construction no provision is made for the catchment and re-use of surplus solution which escapes through the decking of the jetty into the sea below. Canvas screens, which may be adjusted in accordance with the direction of the wind, are fitted. Cattle are passed through the spray in lots ranging from 15 to 20 head, according to their size. The rate at which a consignment may be treated is entirely dependent upon the rate at which the ship is able to receive the cattle. Many delays occur. In order that exposure to the spray may be complete and wetting as thorough as possible, the pump is operated while the beasts enter the spray, for a short period while they are standing confined within the block gates, and during their exit. Lot after lot is so treated as required by the ship.

Results of Spraying.—After the treatment of cattle prior to loading, it has always been the practice to carry out a subsequent inspection on board ship. Observations so made have indicated that in those cases where flies have been fairly numerous, moderate or small in numbers, none have escaped the spray, but in those cases where infestation has been gross or heavy, a few flies have always succeeded in reaching the boat with the cattle. One has estimated in all such cases that the numbers which have so escaped the spray would represent a small fraction only of one per cent. of those which were originally present. A further inspection by the departmental officer is in addition made immediately on the berthing of the vessel at Fremantle, and it is worthy of note that since the inception of spraying operations such inspection has always revealed the cattle to be quite free of infestation. However, to meet the contingency of infestation having persisted or of breakdown of the plant at Derby, a spray by means of which cattle may be treated on board ship before disembarkation has been installed at Robbs jetty. Moreover, an advantage accrues from the fact that when vessels can be certified clean, prior to departure from the northern port of shipment, the release of accumulated manure to Spearwood growers may be permitted.

In addition to the shower spray at Derby, a hand spray has been erected at Broome, from which port comparatively few cattle are shipped annually. Its use appears to be giving equally satisfactory results.

The difficulties of combating Buffalo Fly infestation cannot be overstated when it is remembered that one is dealing with a winged, actively mobile pest. As pointed out, the substances that have so far been used for this purpose rely for their efficacy upon: (1) A transient disabling action which, though rapidly produced, rapidly passes off: (2) A lethal action which is not manifested until the substance actually comes into contact with the fly, thoroughly wetting it. When station cattle are being treated, the crowding in the race which unavoidably occurs renders thorough wetting more difficult to achieve. It would appear that the odd flies that reach the boat on occasions of heavy infestation are those which, having been disabled *in situ*, though not thoroughly contacted with the solution, have subsequently recovered. It is considered that with the use of the more toxic product Benzophen 1 in 32, the difficulty will to a large extent disappear. One assumes

that a second spraying would destroy the few remaining flies. Though conditions of shipping preclude this procedure, it may, nevertheless, as stated, be accomplished at Robbs jetty should the necessity arise.

The task of contacting all flies with the plants at Derby and Broome is in a large measure assisted by a fortuitous circumstance, viz., the conditions under which loading is carried out. On account of hot weather conditions, loading operations are always performed at night. The constant milling of the cattle whilst being worked in the yards and the dust so created, causes the flies to forsake the lower portions of the body, and attracted by the overhead lights, to alight on its dorsal portions, chiefly the back and withers. In this position they are much more easily reached.

Another factor calculated to impair efficiency is the mobility of the fly, and the fact that it appears to be a fairly strong flier. During the months of April and May, when flies have been active, and infestation gross, considerable numbers have been observed in the houses in the township area of Derby, some two miles distant from the stockyards. Having been disturbed during the handling of the cattle, they have reached this area either of their own volition or as the result of having been borne upon the prevailing wind. Fortunately this phenomenon is rarely observed, and though the possibility of such occurring is fully recognised, it does not appear to have played an important part in the reinfestation of treated cattle while awaiting entry to the ship. This factor, however, is obviously one that is beyond the limits of control.

It appears, therefore, that the method of treatment adopted at north-west ports is peculiarly adapted for the purpose for which it is being used, *i.e.*, the treatment of cattle prior to shipment, entrainment, or any other means of transport which will immediately remove them beyond the reach of reinfestation.

It does not appear that this treatment could be recommended in the case of cattle intended for overlanding from infested to clean areas. Such cattle would subsequently be subjected to reinfestation by flies disturbed during their handling and treatment, and to a lesser extent by flies bred in the manure in the vicinity of the stockyards.

Particularly when it is recognised that there is no known substance possessing lasting repellent properties, any method of treatment must obviously embody the immediate removal of treated animals beyond the limits of reinfestation.

Summary.

1. The Kimberley Division of Western Australia is affected by Buffalo Fly infestation; the South-Western Division is free of such infestation. Transport of cattle by sea from north to south involves a definite risk of the spread of the fly to the clean South-West portion of the State.

2. It has been established that the Buffalo Fly is able to pass through all of its life stages even under the mid-winter climatic conditions of Perth.

3. Infested cattle may be treated by means of a shower spray in which a lethal agent is employed, prior to embarkation at the northern port of shipment.

4. When infestation is gross, the efficiency of such treatment appears to exceed 99 per cent. With lesser infestation, no flies appear to survive treatment.

5. Such treatment is practicable from an economic aspect.

6. Further experimental work is recommended with a view to increasing the efficacy of spraying solutions.

7. Treatment can only be recommended in those cases in which some means exist whereby treated cattle may immediately be removed beyond the reach of refestation.

POTATO DISEASES IN WESTERN AUSTRALIA.

THE RHIZOCTONIA DISEASE AND COMMON SCAB.

H. A. Pittman, B.Sc.Agr.,
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INTRODUCTION.

According to the figures given by the Government Statistician in Part V. of the "Statistical Register of Western Australia," for the Seasons 1920-21 to 1929-30, both inclusive, the average annual area under potatoes during this period was 4,689 acres, with an average yield over the whole period of 3.8 tons per acre.

The figures for the various seasons mentioned were as follows:—

Season.*	Acreage.	Yield.	Yield per acre in tons.
1920–21 ...	4,245	13,368	3·1
1921–22 ...	3,612	13,605	3·8
1922–23 ...	3,621	15,198	4·2
1923–24 ...	4,761	17,830	3·7
1924–25 ...	5,122	19,891	3·9
1925–26 ...	4,262	16,052	3·8
1926–27 ...	5,144	17,755	3·5
1927–28 ...	5,280	16,746	3·2
1928–29 ...	4,819	18,774	3·9
1929–30 ...	6,024	27,546	4·6
Average, 1920–30	4,689	17,676	3·8

Such a low average yield per acre is undoubtedly due in a large measure to the prevalence of diseases of various kinds. This is borne out by the fact that the average yield obtained by growers using Government-certified seed, since the inception of the Seed Certification Scheme, five years ago, as computed by Mr. E. T. Morgan, Officer-in-Charge of the Potato Branch, has been from 8-10 tons per acre. Where the manurial and cultural treatments have been identical, certified seed has constantly given a yield of from four to five tons per acre over that of non-certified seed grown alongside. This is very largely due to the reduction of virus diseases in the process of producing the certified seed. In fact, the elimination of disease, in so far as may be humanly possible, constitutes the chief *raison d'être*, or justification, for the existence of the Seed Certification Scheme. Yields as high as approximately 23 tons per acre have been obtained by the use of certified seed.

Up to date the highest yield recorded for Western Australia has been obtained by the use of such seed, and was at the rate of 23 tons 7 cwt. per acre, the same grower having taken 40 tons off two acres. Such yields are, of course, only obtained by a combination of the following factors:—

1. Suitable soils and localities.
2. Seed selection—preferably the use of Government-certified seed.

* For the purpose of the statistical records, the season is taken as commencing on the 1s March in each year.

3. Seed disinfection before planting.
4. Racking of the tubers to secure sprouted seed.
5. Elimination of all tubers on the racks showing "thready eye" or other undesirable characteristics.
6. Careful preparation of the soil, including adequate drainage.
7. Adequate manuring.
8. Careful cultivation during the growth of the crop.
9. Intelligent use, when required, of spray mixtures or dusts to control such diseases as Early and Irish Blights, and also insect pests.

DISEASES.

The following diseases have been recorded on potatoes in this State:—

Name of Disease and Cause.

Rhizoctonia Scab, Stem Canker or Rosette—*Rhizoctonia solani.*
Common Scab—*Actinomyces scabies.*
Eelworm Scab—*Heterodera radicicola.*
Eelworm Scab—*Heterodera radicicola.*
Silver Scurf—*Spondylocladium atrovirens.*
Early Blight—*Macrosporium solani.*
Storage Disease—*Macrosporium solani.*
Bacterial Wilt, Brown Rot or Sore Eyes—*Bacillus solanacearum.*
Irish Blight—*Phytophthora infestans.*
Blackleg—*Bacillus atrosepticus.*
Mosaic—Ultramicroscopic parasite (virus).
Leaf-roll—Ultramicroscopic parasite (virus).
Streak—Ultramicroscopic parasite (virus).
Hollow Heart—Excessive rate of growth in coarse varieties.
Hot Formalin Injury—Tubers left covered too long after treatment with hot formalin.
Flesh (Internal Brown Spot or Spraing)—A complex group. One form is caused by hot, drying winds during the ripening-off period of summer-ing potatoes on sandy soils.

1.—RHIZOCTONIA SCAB, ROSETTE OR STEM CANKER.

(Caused by *Corticium vagum* B. & C.=*Rhizoctonia solani*, Kuhn.)

Susceptible Plants.

This disease is the most widespread of all potato diseases, and it has been recorded from every part of the world where potatoes are grown commercially. The fungus responsible for the trouble is known scientifically by either of the two names given above. The first name is applied to the fungus when in the spore-forming condition, while the second name is that which is applied to the fungus in its much more common sterile condition.

Many other plants beside the potato are attacked, and amongst those which have been recorded in various parts of the world are beets, carrots, lucerne, red-clover, onion, raspberry, turnips, peas, celery, lettuce, beans, cabbage, carnations, parsnip, rhubarb, violets, egg-plants, radish, sweet potato, strawberry, tomato, and spinach. The fungus is a frequent cause of "damping-off" of seedlings. In America, losses ranging from 5 to 50 per cent. of the potato crop in various districts have been recorded on account of the ravages of this parasite. In Western Australia the disease has only become of serious moment during the past few years, as Herbert in 1920 stated that "*Rhizoctonia* is not common here though frequently found in imported potatoes."

Symptoms shown by affected plants.

The disease is best known to the grower and to the general public as hard, sooty-black scabs or fungus-bodies on the surface of the tubers, which will not readily rub or wash off. These black bodies, which really represent resting stages in the life history of the fungus, are frequently very numerous and give the affected tubers the appearance of having been more or less thickly sprinkled with irregular drops of molten pitch or tar. (See Figs. 1 and 2.)

Fig. 1.—Potato tubers showing black *sclerotia* (or resting-bodies) of the fungus *Rhizoctonia solani*.

(Photo. by author from preserved specimens.)

They are known as *sclerotia*, and may vary in size from mere pin-points up to huge structures occasionally covering an area of several square inches. As they do not penetrate the skin, they are in consequence removed when the tubers are peeled.

Nevertheless, their presence is detrimental to the market value of the potatoes, as they considerably detract from their appearance. Their presence on seed tubers is, however, of far greater consequence than in the case of tubers sold merely to be

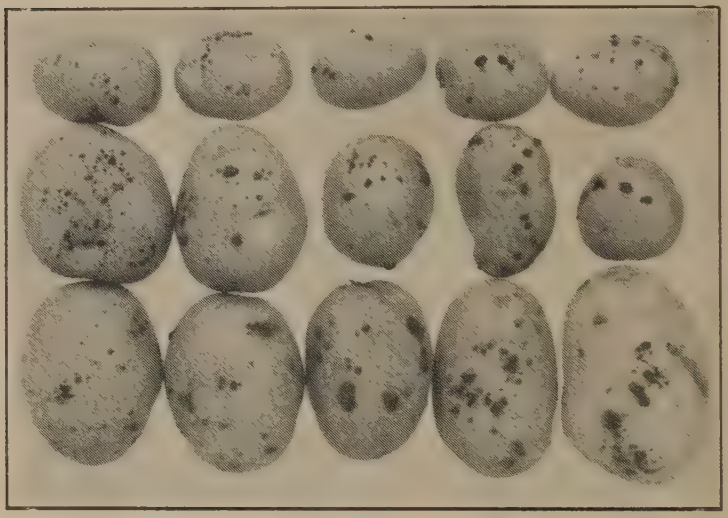

Fig 2.—"Delaware" potato tubers showing the typical black or brownish resting-bodies (*sclerotia*) of the fungus *Rhizoctonia solani*.

(Photo. by author.)

consumed. When infected setts are planted the *sclerotia* give rise to colourless or brown fungus threads which work their way along the surface of the potatoes, or through the soil, to the young potato shoots and may proceed to attack them at the tips or else lower down, causing a dark brown or black canker (see Fig. 3). The result is that many of the shoots are killed, and a greatly reduced stand may result. *This constitutes one of the most serious aspects of the Rhizoctonia disease.* The affected shoots often throw out new buds lower down, and these may in turn be attacked. This attacking and renewed growth may be repeated a number of times, until the sprout is finally killed altogether, resulting in a missing hill, or the plant may break feebly through the soil a long time after the healthy hills are up. Reduction in stand is most commonly caused by *Rhizoctonia* in this State in potatoes planted in spring or autumn.

If the base of the stem is not infected until the plant has gained considerable size, it may not be killed, but a shortening of the internodes at the growing point may result (as a consequence of the reduced water supply, etc., reaching the

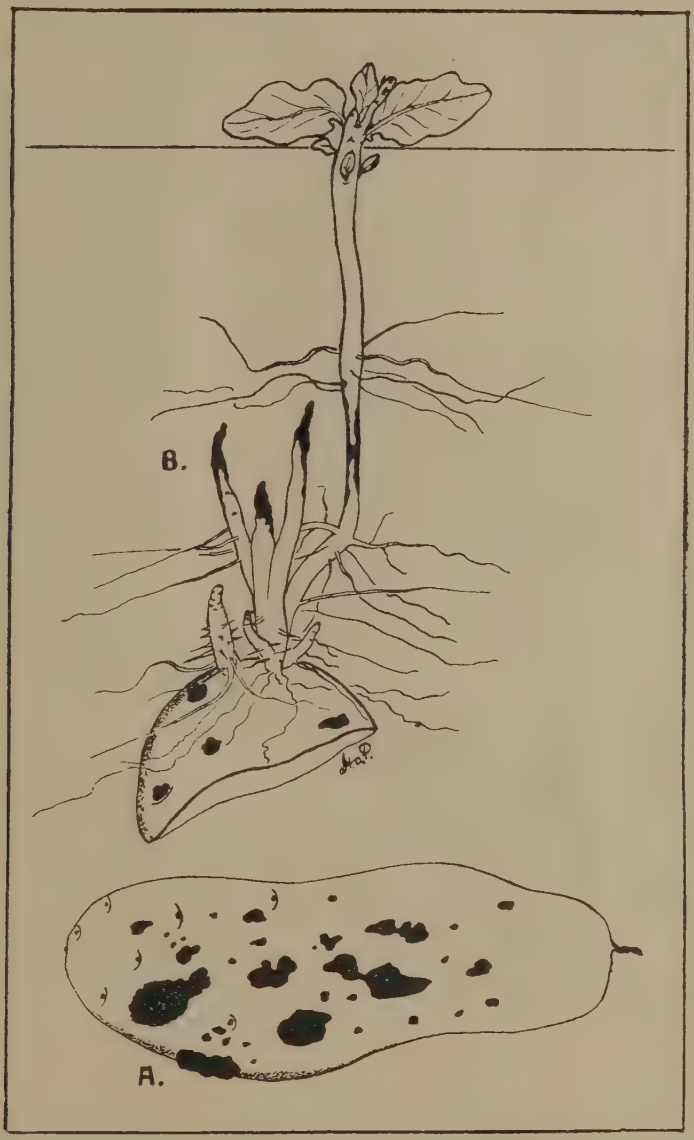

Fig. 3.—A.—Potato tuber showing many resting-bodies or *sclerotia* of the fungus *Rhizoctonia solani.*

B.—Germinating sett showing the killing-back of the sprouts and stem-cankering which may occur when *Rhizoctonia*-infested tubers are planted. *The resultant missing hills or weakling plants constitute one of the most serious aspects of the Rhizoctonia disease.*

growing tissues), and a massed or rosette effect may be given to the topmost leaves. These leaves may turn yellow or remain the normal green. Where the canker on the stem does not penetrate deeply enough to shut off or reduce the supply of water and dissolved minerals, but does penetrate deeply enough to interfere with the movement of sugars down to the tubers, there may result an accumulation of synthesised food materials in the top of the plant. In an endeavour to propagate itself, or at least find an outlet for this accumulation of food materials, tubers known as "aerial tubers" may be formed in the leaf axils on the above ground parts of the stems (See Fig. 4).

Potato plants, which are only attacked by *Rhizoctonia* when fairly well grown, can usually be picked out from a distance by their stiffly erect attitude, the yellowish colour of the foliage, and by the rolling up of the leaflets so that their somewhat lighter-coloured lower sides are rendered very conspicuous. Examination of the stems of such plants below ground level will reveal one or more characteristic brownish cankers more or less encircling the stems.

The cankering phase of the disease is of most serious moment in this State during the spring (in potatoes planted in June-July), and during the autumn (in potatoes maturing in April-May). Deposition of *sclerotia* on the surface of the tubers is apparently stimulated by falling temperatures, and the most thickly infested are those dug from the drained, peaty, swamps in autumn.

In very wet weather the fungus may form a white cob-webby sheath of threads about the base of the stem. This is the reproductive stage of the fungus known as *Corticium vagum*. So far this stage has not been recorded in Western Australia.

It is said that *Rhizoctonia* may cause pitting of the surface of the tubers, but this seems to be very doubtful.

General Considerations.

Rhizoctonia attack is greatly influenced by the environmental conditions. In this connection temperature often appears to be the most important factor. The temperatures at which the fungus does most injury are between 59-70deg. F. Other things being propitious, the fungus is most destructive at a soil temperature of 64deg. F. It thrives best in acid soils, and on this account liming gives good results in its control. Unfortunately the position is complicated by the fact that Common Scab (*Actinomyces scabies*) is *favoured* by liming, and so in avoiding *Rhizoctonia* in this way, one encourages *Actinomyces*. In spite of the fact that acidity favours *Rhizoctonia*, heavy dressings of organic matter such as green manures considerably reduce the occurrence of the disease. Fortunately the same is true of *Actinomyces*, except that *fresh* farm-yard manure stimulates the Common Scab organism. In both cases the provision of abundant dead organic matter seems to divert the unwanted attentions of the parasites into other more desirable channels.

Control.

As *Rhizoctonia* is at present so very widespread, and as it may be present on the tubers as a fine, branched, mass of threads which can only be detected by use of the microscope, all seed-tubers should be treated as if *Rhizoctonia* were definitely known to be present, and irrespective of whether or not they are certified.

The following measures are recommended for its control:—

1. Whenever possible, practice rotation of crops. This is one of the most effective means of controlling any plant disease. Cereal crops such as wheat, bar-

Fig. 4.—"Delaware" potato plant showing "aerial tubers" in the axils of the leaves on the above-ground portions of the stem. These "aerial tubers" are a result of serious mechanical interference with the passage of "manufactured" food materials from the leaves to the underground portions of the plant. While frequently an indication of attack by *Rhizoctonia* they are by no means always so. Continued screwing about of the top of the plant by wind or attack of the stem by insect pests, etc., may have the same effect. The example illustrated was caused by slugs feeding on the stem about ground level, which is indicated on the photograph by the broken line.

(Photo. by author.)

ley, oats, rye, maize and sorghum are not susceptible to Rhizoctonia attack. Susceptible crops (*see* commencement of article) should not be grown more frequently than is absolutely unavoidable in the same piece of ground.

2. Use only selected, Rhizoctonia-free, seed tubers, whenever possible.

3. Avoid planting potatoes, if possible, during the spring or autumn, especially on infected ground, or if the tubers have not been disinfected. In other words, if potatoes are to be planted at these times, the maximum care and attention in the direction of seed-disinfection and selection of "clean" land, etc., is required. Potatoes planted in spring or autumn suffer most from the "reduction-in-stand" phase of the Rhizoctonia disease.

4. Harvest as soon as mature, in autumn-dug crops, in order to prevent rapid increase in the number of *sclerotia* on the surface of the tubers.

5. Plough in as much green manure as possible before potato crops.

6. Irrespective of their source of origin, and whether certified or not, disinfect all seed tubers before planting, in one of the following ways:—

A. *Cold Formalin Dip.*

Soak the tubers, unsprouted and uncut, for 1½ to 2 hours in a solution of formalin made up at the rate of 1 pint commercial formalin to 30 gallons of water. If the tubers are washed, or dipped in water in the bags, and are kept moist for a day or two before treatment, the effectiveness of the disinfectant is increased and the soaking period in the formalin solution may be reduced to half an hour. The solution keeps its strength, but more solution should be added, as required, to keep up the volume to the original level. Tubers may be dipped in formalin solution in any sort of handy container, irrespective of the material of which it is composed. Formalin does not corrode metals, as does corrosive sublimate. At the end of the dipping period the tubers should be spread out thinly in a cool shady place to dry. The cold formalin is not so effective as the others detailed below.

B. *Hot Formalin Dip.*

Soak the tubers, unsprouted and uncut, for three to four minutes, but no longer, in a solution of formalin, kept at a temperature of from 121deg. to 123deg. F., and made up at the rate of one pint commercial formalin to 15 gallons of water. After treatment the tubers should be immediately spread out thinly in a cool shady place to dry. *If this is not done, considerable pitting of the surface of the tubers may result.* The hot formalin solution may be used in metal containers without any danger of corrosion taking place. A supply of the solution, both hot and cold, should be at hand in order to more readily keep the correct temperature in the dipping tank. A carefully regulated fire may be used beneath the tank to keep the temperature around 122 deg. F. The hot formalin dip is more effective than the cold in controlling any "seed"-borne potato disease.

C. *Cold Corrosive Sublimate.*

This is more effective than the formalin treatments for either *Rhizoctonia* or Common Scab.

Soak the tubers, unsprouted and uncut, for 1½ to 2 hours in wooden, earthenware, or cement containers (not metals) in a solution of corrosive sublimate made up at the rate of 4 ounces to every 25 gallons of water (*i.e.*, in a "1 in 1,000" solution). *See formula "f," Table* 1. The solution weakens with use, especially if much dirt is present on the surface of the tubers, or if the tubers are dipped in the

bags, so that one ounce of dissolved sublimate (*i.e.*, 1 pint stock solution as per Table 1) should be added to each 25 gallons, after each lot has been treated. Any water necessary to bring the volume up to the original level should also be added each time. *An entirely fresh solution should be prepared after treating four lots.* Each 25 gallons of solution treats about 5 bushels of tubers.

Dip the tubers in wooden crates, not bags, or else immerse directly into the barrel or vat, if provision has been made to drain the solution into another container after the treatment. The effectiveness of the treatment is increased by dipping the tubers in water, or by washing them, and keeping them moist for a day or two before treatment. If this is done the soaking period in the corrosive sublimate may be reduced to half an hour. Also, if the tubers are washed to remove dirt before dipping, and are not immersed in the bags, the solution may be used *six to eight times* before discarding, provided it is strengthened each time as described above. The temperature of the solution during treatment should be not less than 45deg. F. nor more than 70deg. F. If the temperature of the water is more than 70deg. F., the time of treatment must be reduced.

The tubers must be dried thoroughly after treatment by being thinly spread out on racks, etc., or the action of the poison will continue, and damage to the seed may result.

D.—*Hot Corrosive Sublimate*—

This is the most recent and apparently also the most successful method of treatment of tubers as a preventative against *Rhizoctonia* and other "seed"-borne potato diseases. The treatment necessitates a wooden tank being used. The strength of the solution is four (4) ounces of sublimate to twelve and one-half gallons of water, but the solution is heated to 110-113deg. F. by injecting steam through a rubber hose from a small boiler or heating plant. The potatoes are dipped for *five minutes* in wooden crates, and are then spread out thinly to drain and dry. The tank used must have a water capacity considerably in excess of the volume of the tubers to be treated at any one time, so that the temperature can more easily be kept uniform. All metal parts of the crates, etc., must be coated with asphalt-paint, tar or pitch to prevent corrosion.

It is not anticipated that many growers will be in a position to adopt this treatment at present, but the method is indicated so that progressive large-scale farmers may take advantage of this information if they so desire, and consider that the saving in time, etc., is worth the expense of the treatment. If adopted, the strength of the solution must be kept up from time to time as indicated above in Section C.

PREPARATION OF CORROSIVE SUBLIMATE SOLUTION FOR DISINFECTION OF POTATO TUBERS, ETC.

Stock Solutions Recommended.

Corrosive sublimate (mercuric chloride) is the chemical most commonly used for the disinfection of vegetable and flower-garden seeds, potato tubers, etc., the most frequently used formula being that known as "1 in 1,000." This means 1 part by weight of Corrosive Sublimate (Mercuric Chloride) to 1,000 parts by weight of water. In publications originating in the United States of America, the directions for making up this "1 in 1,000" strength, are to dissolve the Corrosive Sublimate at the rate of 1 ounce in 7½ gallons of water. In British countries, however, the gallon measure used is larger than that used in the U.S.A., so that

the correct formula when using the Imperial gallon as a measure of volume is at the rate of corrosive sublimate 1 ounce avoirdupois in every 6¼ Imperial gallons of water (or 4 ounces to every 25 gallons).

Where large quantities of Corrosive Sublimate solution are required, as in the disinfection of potato tubers or gladiolus corms, *the most convenient method of preparation is to make up a stock solution at the rate of one pound of finely-powdered sublimate in two gallons of hot water.* The poison may be dissolved by carefully pouring the hot water over it in the bottom of a wooden, earthenware, glass or enamelled vessel. After cooling, the solution should be stored in a tightly-stoppered, clearly-labelled, glass or earthenware jar, etc., under lock and key, till required. **Metal containers must never be used for Corrosive Sublimate solutions, as they are corroded by the disinfectant.** The chemical only dissolves very slowly in cold water, so that hot water should be used whenever possible in making up the stock solutions.

Table I.

DILUTION TABLE FOR MAKING 1 IN 1,000 CORROSIVE SUBLIMATE SOLUTION, USING A STOCK SOLUTION OF ONE LB. CORROSIVE SUBLIMATE IN TWO GALLONS OF WATER (OR HALF LB. IN ONE GALLON).

Stock Solution. Take amount indicated below.	Amount of dissolved sublimate in quantity of stock solution taken.	Dilute with clean cold water in wooden, glass, cement or earthenware container to the volume indicated below.
(a) ½ pint	½ ounce	1 gallon 4½ pints
(b) ¾ ,,	¾ ,,	3 gallons 1 pint
(c) ¾ ,,	¾ ,,	4 ,, 5½ pints
(d) 1 ,,	1 ,,	5 ,, 2 ,,
(e) 1 quart	2 ounces	12 ,, 4 ,,
(f) ½ gallon	4 ,,	25 ,,
(g) 1 ,,	8 ,,	50 ,,
(h) 2 gallons	1lb.	100 ,,

In cases where it is anticipated that only very little of the disinfectant will be required, a more convenient stock solution may be prepared by dissolving ½ *ounce* of Sublimate in *one quart* of hot water (or *two ounces in one gallon*) by the same method as indicated above. For use this second stock solution is diluted as follows:—

Table II.

DILUTION TABLE FOR MAKING 1 IN 1,000 CORROSIVE SUBLIMATE, USING A STOCK SOLUTION OF ONE HALF OUNCE (½ oz.) IN ONE QUART OF WATER (OR TWO OUNCES IN ONE GALLON.)

Stock Solution. Take amount indicated below.	Amount of dissolved sublimate in quantity of stock solution taken.	Dilute with clean cold. water in wooden. glass, cement or earthenware container to final volume indicated below.
(a) ¼ pint	1/16th ounce	3½ pints
(b) ½ ,,	1/8th ,,	6½ ,,
(c) ¾ ,,	3/16ths ,,	1 gallon 1¾ pints
(d) 1 ,,	¼ ,,	1 ,, 4½ ,,
(e) 1¼ pints	3/8ths ,,	2 gallons 2¾ ,,
(f) 1 quart	½ ,,	3 ,, 1 ,,
(g) ½ gallon	1 ,,	6 ,, 2 ,,
(h) 1 ,,	2 ounces	12½ ,,

The strengths of all stock solutions should be written on the labels as soon as the solutions are prepared, and it would be just as well also to include a copy of the appropriate dilution table on the same or a separate label on the container.

Mercuric Chloride (Corrosive Sublimate) is deadly poisonous to human, animal or plant life. In addition, it is colourless, odourless, and comparatively tasteless, and may easily be mistaken in solution for pure water. It should, therefore, be used with great care and kept out of the reach of children or farm

stock. When finished with, the solution should be poured into a hole in the ground, and the hole be immediately filled in or covered over. In case of mercuric chloride poisoning give whites and yolks of eggs mixed with milk. In emergency, ordinary flour paste may be used. Then give a mustard emetic to induce vomiting and send immediately for medical assistance.

2.—COMMON SCAB.

(Caused by *Actinomyces scabies* (Thax.), Güssow.)

Plants Susceptible.—This disease is found not only on the potato, but has also been recorded by various observers on beetroot, turnips, mangels, rutabagas, parsnips, radishes and carrots amongst others. On potato, the disease is fairly common in Western Australia in certain districts, and especially so where the tubers are grown on soil which has been rendered somewhat alkaline by liming, or in any other way, such as by the burning-off of the native vegetation.

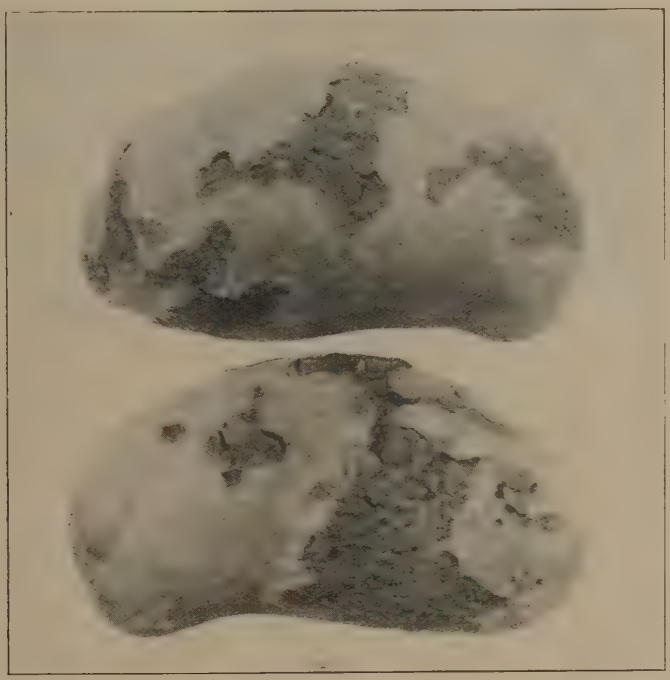

Fig 5.—Common Scab of potatoes due to *Actinomyces scabies*, showing both sides of the one tuber badly affected.

(Photo. by author.)

Symptoms.—In typical cases this disease can be readily distinguished from eelworm-scab, which is the only other disease present in this State with which it could possibly be confused. The disease is characterised by the presence of roughened and fissured corky areas on the surface, which contrast strongly with the smooth, lighter-coloured, unaffected neighbouring tissue (see Fig. 5). When

isolated the diseased areas are generally approximately cylindrical, and they usually show a small series of more or less concentric corky ridges and corresponding fissures. The margins of the lesions are generally ridged up above the level of the surrounding healthy skin (see Fig. 6). Only a single lesion may occur on a tuber, but more commonly there are several, and occasionally there may be so many that it is difficult to find an area of unaffected skin. The lesions commence as

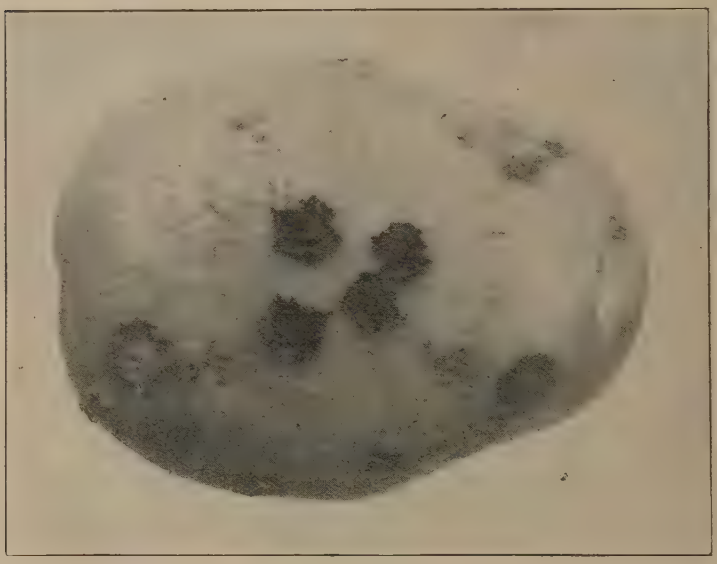

Fig 6.—"Delaware" potato tuber showing several approximately circular Common Scab lesions which have begun at *lenticels* (breathing-pores) and are gradually extending in area.

(Photo. by author.)

small rusty-brown specks at the breathing pores or lenticels. From these positions they gradually work outwards, and in the course of time may coalesce and form areas of very great extent (see Figs. 5 and 7). In bad cases the whole surface of the tuber may be covered with lesions. Secondary organisms frequently then take control and may soon reduce the tuber to a disintegrating rotten mass. On being dug up, potatoes affected with Common Scab frequently show a very delicate whitish film of *Actinomyces* covering the diseased areas. This very quickly dries up and disappears on exposure to air and light.

Common Scab lesions may be elevated above the general surface of the tuber in the form of warts or blisters, having the outward appearance of eelworm-galls, or they may be nearly on a level with the remainder of the potato skin, or again they may be deeply depressed.

Cause.—As stated above this disease is due to *Actinomyces scabies*. The organism is peculiar in that the genus to which it belongs consists of bacteria which form long, thread-like, multi-cellular filaments, which strongly suggest the *hyphae* or threads of the higher fungi. These threads very readily break up, however,

into normal, unicellular, rod-like bacteria. These are able to live on the organic matter in the soil as well as on the surface of the potato tubers and the underground parts of certain other plants. (*See* section of article dealing with susceptible plants.)

General Considerations.—*Actinomyces scabies* is greatly stimulated by the addition to the soil of lime, wood ashes, or any material which will tend to render the soil alkaline. It is for this reason that potatoes following cabbages or other crucifers, which have been heavily limed for the control of Clubroot (*Plasmodiophora brassicae*), are often badly affected with Common Scab. Acidity is unfavourable to its devolpment, and therefore the use of acid fertilisers such as superphosphate, sulphate of potash and sulphate of ammonia will tend to reduce

Fig. 7.—Common Scab due to *Actinomyces scabies* on both halves of each of two "Delaware" potatoes grown on a drained peaty swamp rich in lime.
(Photo. by author.)

the disease. As nitrate of soda, if used for a considerable period, tends to render the soil reaction alkaline, it should not be used where Common Scab is likely to be in evidence. It is unfortunate that alkalinity is favourable to Common Scab, because by increasing the soil acidity to reduce attack by *Actinomyces*, the effect is to encourage *Rhizoctonia*. It has been shown, however, that attacks by both *Actinomyces* and *Rhizoctonia* are reduced by increasing the organic matter of the soil. The grower therefore should make every effort to increase the humus content of the soil by the incorporation of green manures, etc., if his soil is at all deficient in organic matter.

Common Scab is most serious where the soil temperatures are high. It has been shown that it does most damage—other things being favourable to it—at a soil temperature of about 68-77deg. F. The range of development of the disease is given by Jones, McKinney and Fellows as from 11 to 30.5deg. C. (51.8 to 86.9 deg. F.) with but slight infections at either extreme. In certain field trials 77 deg. F. was the most favourable temperature for scab development. Low moisture content favours the disease, **so that scab is most serious under a combination of soil alkalinity, high soil temperature and low soil moisture.**

Control.

1. If the soil is badly infested with *Actinomyces*, rotate with other non-susceptible crops. Grasses, cereals or clovers could be used in rotations with good results. Do not use root crops in rotations. A susceptible crop should not be used more frequently than every third year on the same piece of ground.

2. Use clean seed whenever possible. "Avoid the use of badly scabbed tubers for seed, as they will always produce more scab than clean seed, even when given a standard seed treatment." (Heald.)

3. No matter what the source of origin, and whether they are certified or not, treat all seed tubers with formalin or corrosive sublimate (mercuric chloride) as recommended for the control of *Rhizoctonia*.

4. Substances tending to cause soil alkalinity such as lime or wood ashes should not be applied to the soil immediately before growing a potato crop. If they must be used, they should be applied to other crops preceding the potato crop by as long a period as possible.

5 Every attempt should be made on soils at all deficient in organic matter to increase the humus content and the acidity of the soil by the ploughing-in of green manure crops.

6. Avoid using nitrate of soda as it tends to increase the soil alkalinity. Use sulphate of ammonia or blood and bone instead as sources of nitrogen.

As indicating the effect of acidity in reducing the amount of Common Scab, it is interesting to note that in certain parts of America where potatoes are very often grown for many years without a change of crop, the harrowing-in of from 300 to 450 pounds of "inoculated" sulphur before the potatoes are planted has given very good control. This treatment has not been tried out in Western Australia, and no recommendation can be made concerning it.

7. Keep up the moisture content of the soil by irrigation, etc., where practicable, on soils inclined to dry out during the summer.

8. Do not feed uncooked scabby tubers or peelings to animals, and avoid dumping scabby tubers or peelings on the compost heap or fields.

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ERADICATION OF LICE AND TICK IN SHEEP.

A. McK. Clark, L.V.Sc.,
Chief Veterinary Surgeon.

The necessity for stockowners to keep their sheep free from ticks and lice cannot be emphasised too strongly. Apart from the compulsory dipping aspect, it is a reflection on good management if every effort is not made towards the eradication of tick and lice from flocks. Owing to the knowledge available no difficulty should be experienced in this regard. Dipping is always associated with good animal husbandry in this State, for one cannot obtain a maximum of return for wool if it has suffered the effects of the ravages of parasites. The plea that one is unaware that such parasites exist shows that insufficient care is being exercised in supervision. On the other hand, to be aware of the existence of tick and lice and fail to adopt remedial measures is even more culpable. To travel or expose for sale in a public place sheep which are affected with ticks or lice becomes an indictable offence for which penalties are provided under "The Stock Diseases Act, 1895."

Although the action taken by the Departmental officers during the last few years has had the effect of bringing about a considerable improvement in the flocks, there is room for greater improvement yet, especially amongst those flocks where sheep are never exhibited for sale. Tick and lice in sheep, if allowed to continue, must eventually go from bad to worse, therefore all persons concerned should realise the position and determine on the right lines to stamp out the trouble.

Remedy.—In order that a remedy may be effected, it is first necessary to obtain evidence by examination as to the existence or otherwise of lice or tick in your sheep. In order to do this the sheep should be seized and placed in a sitting position between the feet of the operator with the back of the animal resting against the legs. Special attention should then be paid to the unexposed portion of the body between the chest and the forearms—on the belly, beneath the jaw and the under portions of the neck. Afterwards the back and flanks should be examined.

A full description of both the sheep louse and the sheep tick and how to identify is supplied in this article by Mr. L. J. Newman, Economic Entomologist.

Dips and Dipping.——The class of dip used depends upon the number of sheep required to be dipped. For general requirements one cannot do better than adopt the type recommended by the Departmental Sheep and Wool Expert (Mr. McCallum), particulars of which have been previously published but which are reproduced in this article. This can be modified so suit requirements peculiar to the owner.

The best time to dip is one month off shears for short wools, and six weeks for long wool varieties. However, in some parts of the State one recognises the difficulty of a second muster, and in those cases dipping off shears is the only alternative. When this is the case every care should be taken to see that the animals are effectively dipped—preferably in a swim dip.

The advantage of dipping with a month's wool on is obvious, as it affords an opportunity for the solution to take hold, and in consequence the efficiency of the operation is enhanced. Care should be taken not to dip sheep when hot after travelling or when thirsty. Thin sheep require more gentle handling than strong

vigorous ones. When dipping off shears it is always advisable to dress shear cuts with a dab of antiseptic dressing, supplied by dip manufacturers, before immersing.

Kinds of Dip to use.—There are many makes of dip on the market, but the only kind recommended by this Department is one containing one-tenth per cent. of arsenious oxide. This class of dip has been proved throughout the Commonwealth to be the most efficacious, and, in consequence, the cheapest in the long run.

Lime and sulphur dips should be avoided except in cases of scab. Lime has a detrimental effect, as it causes the fleece to become hard and harsh in texture, stunted in growth, and a bad colour. From a manufacturing standpoint these are most objectionable, causing dyeing faults and ultimately, indifferent fabrics.

Lime renders fibre brittle, stunts growth, destroys elasticity, causes difficulty in scouring, spoils it for taking dyes, and, finally, can only produce low grade fabrics.

Tobacco dips are objectionable, as wool from sheep so dipped is not suitable for making even ordinary fabrics, and, further, has been proved absolutely useless in regard to the destruction of lice and tick.

Carbolic and alkali dips are not recommended, for the reasons set out in connection with tobacco dips.

The only point to remember in connection with the use of the prescribed arsenical dip is to carefully execute the directions issued by the manufacturers given on packet or container.

The dip should be tested from time to time, so as to ascertain the right strength is being maintained.

THE SHEEP LOUSE.

Hugh McCallum,
Sheep and Wool Inspector.

ECONOMIC ASPECT.

Owing to the ravages of the external parasites which are infesting our flocks, namely, lice and tick, our wool, and also the carcase, has suffered considerable depreciation. In these times of great demand for wool and sheep at high prices we cannot afford to temporise with these parasites. The sheep farmer must come to a realisation of the fact that unless he makes a determined effort to eradicate or control these pests, they will sooner or later reduce his sheep and wool to such a state that they will prove unprofitable.

Many of our local clips have held their own with the best of Australia. It has always been noted that the highest values obtained for sheep or wool have been from those sheep that had the necessary care and attention. The owners of these

high-priced wools have shown a careful and intelligent interest in their sheep. The stations or farms have been equipped with facilities for dipping, draining yards, etc.

The prevention of this ever-increasing loss is not a matter of difficulty. The initial outlay in providing the dips and other facilities is soon offset by freeing the sheep of the parasites and the consequent heavier fleece and carcase, which means enhanced prices. It is a great and common mistake of many farmers to neglect these provisions on the grounds that they cannot afford the outlay. "A stitch in time saves nine" is a very true saying, and is very applicable when dealing with lice and tick. A pound spent in prevention or treatment means the saving of many pounds later on.

Sheep that are infested with these parasites give birth to weakly lambs. These in turn become infested, and their development is greatly retarded; thus again is the farmer the loser.

Wool freed from tick and lice is bright, clean, and attractive contrasted with that produced by infested sheep, which is of much inferior quality. It is difficult to estimate the actual financial loss which follows neglect, but sufficient is it to state that it runs into many thousands of pounds per annum.

There is another aspect of the case which is a serious one, namely, the infestation of clean sheep by the yarding of infested sheep in public or private saleyards. These yards become infested, and clean flocks which are being offered for sale pick up these lice or ticks. This often means that the buyers unknowingly take infested sheep on to their property, and thus introduce the pest into otherwise clean areas.

Some difficulty may be experienced by farmers in recognising these pests, but it is hoped that a reference to the notes provided in this article by the Entomologist will assist in this respect.

It is the hope of this Department that before many years all farmers will be the possessors of sheep which are a necessary adjunct to successful farming—hence the reason for all concerned being made acquainted with the need for taking all precautions against the introduction of these pests and making themselves acquainted with the methods of prevention and treatment.

Sheep Parasites and the Dip.—When sheep are infested it is necessary that a dipping mixture be applied to destroy the parasites. Sheep are often rushed through the bath, with the result that the dip does not reach the skin, and consequently the pests remain more or less unaffected by the treatment. The dip must penetrate to the skin, not only to destroy the existing parasites, but to protect the animal against becoming re-infested. It is imperative that all owners realise the importance of this and discontinue the habit of rushing the sheep through the dip. Regular dipping is essential, and the instructions issued regarding this must be strictly carried out. Each animal put through the dip requires to be soaked for not less than a minute. Sheep should be dipped from four to six weeks after shearing.

To make a complete success of dipping it may be necessary to repeat the operation some 20 to 25 days later. This, as the Entomologist points out, is owing to the failure of the first dip to destroy eggs or pupæ, which are very resistant stages.

Care before and after Dipping.—Adverse climatic conditions at the time of dipping can, and do, have a detrimental effect on the result. They are, however, beyond our control, but by using a dip of unvarying and guaranteed constancy and following the instructions, good results will be obtained. The care and condition of sheep before and after dipping are matters which should not be overlooked.

Sheep should not be dipped during extremes of heat or cold, when thirsty, or in a heated state from driving. When ewes and sucking lambs have been dipped the lambs should be kept apart for a time.

In districts where each farmer cannot afford to put in a separate dip, the matter of installing one on the co-operative system should meet with general support. This can be erected at little cost by the interested parties.

For the information of farmers a diagrammatic plan of an effective sheep-dipping tank has been prepared, and is submitted herewith.

The particulars regarding the materials used in the preparation of the dipping fluid will be found in "The Eradication of Lice and Tick in Sheep," by Mr. Murray-Jones, the Chief Veterinary Officer.

EXPLANATION OF DIAGRAM.

Sheep-dip—"Walk in" Entrance. (*See plan.*)

A and *B* are supply and crush pens, which are fed from the usual sheep yards, with which the former should be connected. The latter should have a battened floor, the battens being made in sections, so that they can be removed after dipping.

C race, nine feet in length, 16 inches wide, sufficient to hold four sheep. This race should have a battened floor, to be removed after dipping.

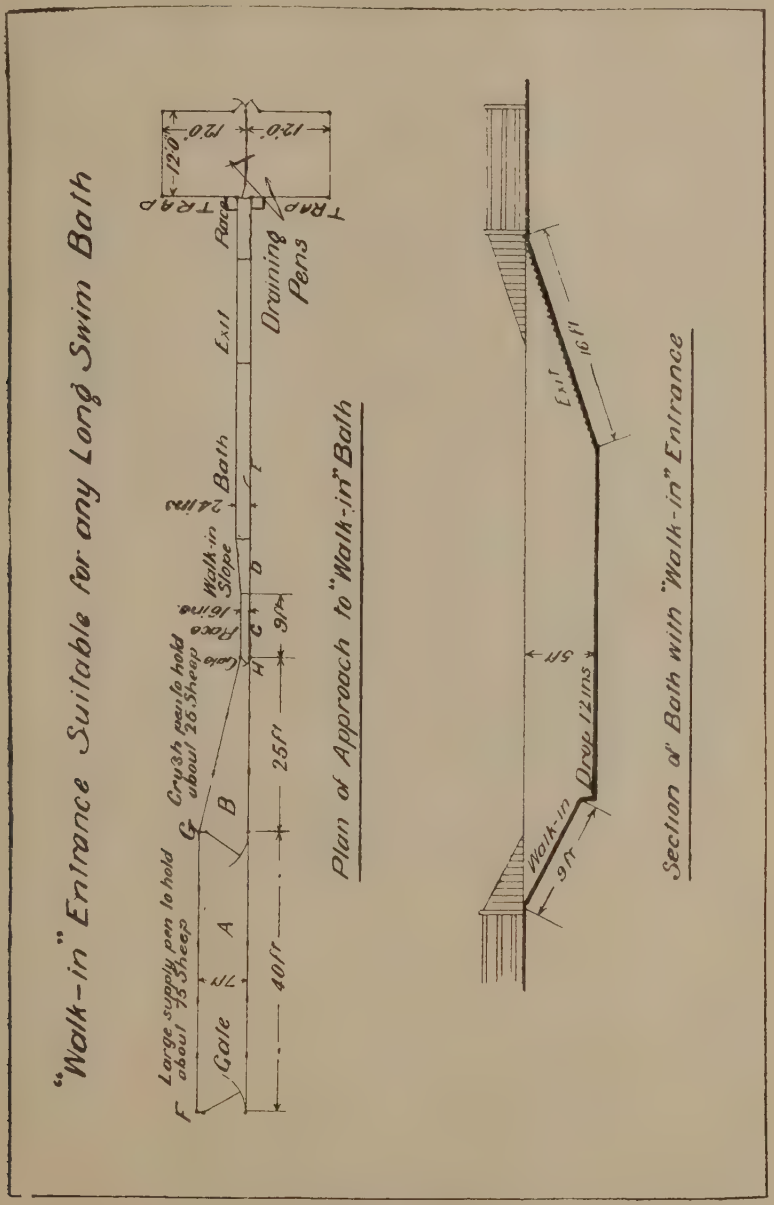
D represents the "walk-in" section, and is an incline nine or 10 feet in length (10 feet is better), gradient one in two, ending in a drop of 12 inches above the bottom of the bath. Its width at the point at which it connects with the race is the same as that of the race itself, namely, 16 inches; hence it gradually widens to 24 inches, to connect with the bath at the other end, of which it practically forms a part. The sides of the "walk-in" section are also, in all respects, identical with those of the bath.

E, portion of the swim bath.

F, *G*, *H*, represent gates: *F* and *G* are 4 to 4½ feet gates hung on posts 3 feet or 2½ feet from the side fence, so that when open they will close up the angles and form a "lead-in." *H* is a small gate to close the four sheep in the race.

Two draining pens, each 12 by 12, are necessary, and a shed could be erected over same if required.

The size of the above dip can be reduced to meet the requirements of the small stock owner. A dip from 15 feet to 25 feet long is large enough for a small flock.



A Modern Sheep-dip.

EXTERNAL PARASITES OF SHEEP.

L. J. Newman, F.E.S., Entomologist.

SHEEP LICE.

Amongst insects which continually live on domestic animals, propagate on them, and when their numbers increase cause serious injury to their host, none is perhaps worse than the various species of lice.

During the past few years these parasites have shown considerable increase amongst our flocks. In Eastern Australia it is stated that the heavy annual loss to the material wealth resulting from the presence of lice amongst sheep is immense, being greater than that caused by the so-called Sheep Tick (*Melophaga ovinus*).

Sheep infested with Louse and Tick. Note torn and ragged condition of fleece, due to rubbing.

Two species of lice have been determined as present and infesting our local sheep, namely, the Red Headed Sheep Louse (*Trichodectus sphaerocephalus*) (*Nitzsch*) and the Foot Louse (*Linognathus pedalis*) (*Osborn*). They belong to the Order *Hemiptera* and to the Sub-Orders *Mallophagidae* and *Anoplura*. In the Sub-Order *Mallophagidae* all members are parasitic, and are known as the biting lice. They do not suck blood by means of a proboscis or beak. Their mouth parts are formed for feeding upon hair, feathers, skin, scales, clots of blood (formed by the infested animal scratching and biting itself) and scabby or other scurvy material found upon the skin or amongst the hair and feathers of their hosts. These lice are most commonly found upon birds. Nearly all farm animals, however, are subject to infestation by some species of this sub-order.

The *Mallophagidae* or biting lice are all small flattened insects, having large prominent head, outstanding eyes, and short, three-jointed antennae or feelers. The legs are short and stout, fitted for holding to and also moving among hair or feathers. The tarsus or foot is terminated with a sharp claw.

The eggs, commonly known as "nits," are fastened to the hair or feathers of the host. The young issue from the eggs in a few days. They resemble their parents, except in size, and reach sexual maturity by a series of moults. Their entire life is passed on the host. They are spread from animal to animal mainly by means of contact. Other mediums of spreading are posts, fence wires, tree trunks,

Tag of wool in mouth of sheep pulled out in its effort to get at the irritation.

and objects against which the lice-infested sheep scratch themselves. Infested wool is often left clinging to these containing either "nits" or living lice. Clean sheep may rub against these objects and thus become infested.

The second group of lice, namely, the *Anoplura*, are the true blood suckers. They differ primarily from the preceding group in that their mouth parts are formed for piercing the skin and sucking up the blood of their host. Further, they are only found infesting mammals (those animals which suckle their young). Their life history is similar to the biting lice and, therefore, needs no further description at this juncture.

All breeds of sheep appear to be subject to the irritating attacks of lice and tick. Animals attacked by lice are extremely annoyed by them, and fall away considerably in condition, partly by the abstraction of juices and partly by the uneasiness which the itching occasions. We not infrequently observe sores on the surface of the skin arising either from the gnawing of the lice or from frequent rubbing of the animal against the fence posts, trees, etc. Sheep often tear off their own wool in their endeavour to get at the itching skin.

The presence of lice can be detected by the tufts projecting over the uniform surface of the fleece. The cumulative increase of lice is very rapid, especially upon animals which have became poor in condition through lack of proper nutritive

Infested sheep, showing typical tufts of wool projecting over the uniform surface of fleece.

foods, or due to some disease. The exceedingly prolific increase has led to the vulgar statement that a louse might be a grandfather in 24 hours. This is, of course, not literally true, but simply indicates that when animals which have become infested and probably living under dirty conditions are not attended to, they soon become poor in condition and consequently heavily infested with lice.

Another important fact, other than the loss of weight and ragged texture of the wool, is the depreciation of the fleece by staining, which arises from the excreta of the lice.

THE RED-HEADED SHEEP LOUSE.

(*Trichodectes Sphaerocepha'us, Nitzsch.*)

Description.—This little red-headed louse is very small, slightly exceeding 1 25th of an inch when full grown. It is of a pale brownish colour, almost transparent, with the head more dense and reddish, body flattened, head broader than long, eyes out-standing, antennae short and three-jointed, legs short, thickset, and yellowish, with one terminal claw, eggs or "nits" fastened on to the wool, dirty

white, hatching in from six to eight days. The young reach sexual maturity in 16 to 18 days from hatching. Thus we have a complete life cycle every three weeks. The adult insect is apterous or wingless, and may lay 100 or more eggs.

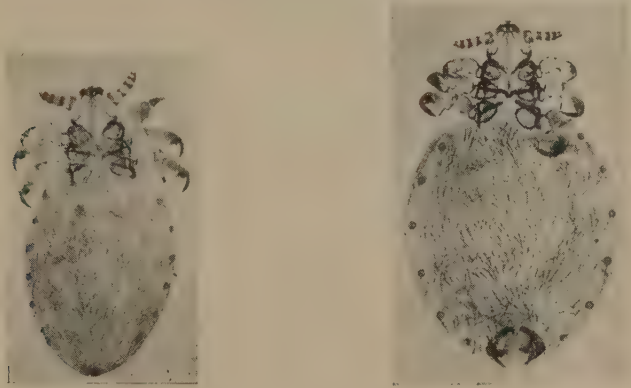
Red-headed Sheep Louse.
Trichodectes sphaerocephalus (Nitzsch).
× 50.

This louse is distinguished by the darker dorsal median bands on each of its abdominal segments, and is only found infesting sheep. It is commonly found near the skin, on the upper parts of the neck, shoulders, back, and thighs. When in great numbers on an animal in low condition, it will be found on all parts of the body.

SHEEP FOOT LOUSE.

(*Linognathus Pedalis, Osborn.*)

This insect has been discovered during the past year or two infesting sheep in several districts. As its name infers, it is found about the feet, fetlocks, and undersides of the legs towards the belly. It differs entirely from the previously described louse in size, shape and mouth parts.



Sheep Foot Louse, Linognathus pedalis (Osborn).
× 50 Male. × 50 Female.
(Original.)

Its mouth parts are adapted for piercing the skin and sucking the blood of the host animal. It follows, therefore, that should it become abundant upon an animal, the injury would be more severe than that caused by the biting lice which do not puncture the skin.

Fortunately, this pest is, so far as we know, confined to several isolated areas, whereas the biting louse is more or less widespread thoughout the State. As far as I have been able to ascertain there does not appear to be any previous record of this insect in Australia. (*Haematopinus ovillus*) has been reported in New South Wales (see *Journal of Agriculture*, April, 1923). Judging, however, from the statement therein made that the eggs were found on the wool of the belly, legs, and thighs, I am of opinion that the louse then found is identical with the one herein recorded (*Linognathus pedalis*).

Portion of wool from fetlock of sheep, showing masses of louse eggs or "nits." (Original.)

Description.—The foot louse has a short head, as wide as it is long, which merges into the thorax, mouth parts for piercing or sucking. There are no eyes apparent. The antennae large, five-jointed, pointed, terminal joints with three or

four bristles. The body is about 1 12th of an inch long and 1 25th of an inch wide, being considerably longer and wider than the biting lice. The males are broader and flatter than females. The legs are strong and terminated with a powerful claw. Anterior or front pair smallest, posterior pair largest. The white eggs

The Sheep Tick—Female.
Melophagus ovinus (Linn).
× 13. (Original.)

or "nits" are attached to the wool on lower part of leg and foot, a short distance from the skin. They take slightly longer to hatch, but otherwise the life history is very similar to the sheep louse.

There are other lice infesting our pigs, horses, etc., but the purpose of this article is to deal only with those species infesting sheep.

THE SHEEP TICK.

(*Melophagus ovinus*, Linn.)

This so-called tick is not a true tick, but is a wingless parasitic fly which passes the whole of its life stages on the body of the sheep. There are various vernacular names attached to this insect, namely "Ked," "Louse Fly," and "Sheep

Tick." It is a blood-sucking insect that is now widespread in many sheep-producing countries, and is certainly well established and widespread throughout the flocks of this State.

This wingless fly belongs to the great Order of *Diptera, Family Hippoboscidae, Genus Melophagus.* This insect is curious in that it does not lay eggs as do most *Diptera* or flies. The egg is retained within the body of the mother, hatches therein, the larva becoming full grown. It is then given birth to, enveloped in a soft membrane, which quickly hardens into a shell around the larva, forming what is called a puparium, wherein it pupates. The larval stage of this fly does no harm whatever, the blood-sucking habit of the adult being the cause of all the trouble. The pupa is attached to the wool by a glue-like substance. These shell-like pupæ are in error called eggs.

Pupa of Sheep Tick, in error called the egg.

In from 20 to 25 days after being deposited the pupa is broken open by the tick, which emerges and becomes at once an active blood sucker. Four to six days later it reaches sexual maturity, and 10 to 12 days later the female deposits her first pupa. Each female is capable of depositing several pupæ. We therefore have the following life cycle egg and larval stage within the mother seven to 10 days, from birth of larva enveloped in soft pupa case to emergence of tick 20 to 25 days, in 12 to 14 days after emerging from the pupa the female is depositing her first pupa. The life cycle is completed every 39 to 49 days.

In treatment, therefore, it is necessary to repeat the dipping 20 to 25 days later, thus destroying any ticks that may heve emerged from pupæ which resisted the first treatment.

Description.—As before stated, this insect is not a true tick, but is a wingless fly. It has six legs, whereas the true ticks have eight when adult. The mouth parts are very similar to those of other blood-sucking flies. The legs are fairly long, strong, and terminated with two powerful long claws. The antennae are unobservable. Upon the head may be seen a pair of stout stylets, the piercing mouth structures, which are tipped with several strong hairs. The adult is about a quarter of an inch long, of a reddish or grey-brown colour. The body is distinctly divided into head, thorax, and abdomen, which again distinguishes them from the true ticks, which have the thorax and abdomen fused, with a very inconspicuous head. The forepart of the body is uncommonly small. The abdomen is, however, proportionately very large, especially when the insect is well gorged with the blood of its host

or is carrying a well-developed pupa. They have a rapid motion when disturbed, running rapidly forward or sideways and backwards like a crab. The neck, breast, shoulders, belly, and thighs are the favoured locations on the host.

Injury.—This parasite, like the blood-sucking lice, lives upon the blood of sheep, which it obtains by sinking its sucking tube into the flesh.

When numerous they cause great irritation, loss of blood, interference with feeding, with consequent loss of condition and vitality. The sheep, when brought to this condition, are then unable to resist other diseases. The wool is lowered in value owing to its being soiled with the excreta and matted together with pupæ. The sheep also scratch, bite, and rub themselves, causing the fleece to become ragged and broken in staple. The lambs of the flock suffer most from the ravages of this pest, and, if they become heavily infested, receive a set-back at an important period in their development.

Infested wool clinging to wire fence after sheep have been scratching.

How the pest is spread.—Although this insect does not seem to possess the instinct of migration to any extent and cannot fly, nevertheless, once introduced into a flock it soon spreads. This is particularly so where sheep are frequently herded or yarded. When in contact with each other the tick readily passes from one animal to another. There are other means of spreading, such as on dogs or other animals which have come in close contact with infested sheep. Men working amongst infested sheep sometimes carry the parasite on their clothing, and may thus be the means of introducing them into a clean flock. Scratching posts, fences, wires, trees, etc., against which the sheep have rubbed and dislodged some infested wool may be the medium of conveying the pest to a clean sheep should same come in contact. If tick is suspected, part the wool over the neck, breast, shoulders, belly, and thighs, when they will be readily detected (Fig. 5).

In the interests of the sheep and wool industry, it behoves all owners to make themselves acquainted with these external parasites, so that they can recognise these pests in their initial stages of introduction to the flock. The next step is to take prompt and correct measures for their treatment, and if possible, eradication.

Wool on neck of infested sheep parted, showing ticks and pupae.

REGULATIONS UNDER "THE STOCK DISEASES ACT, 1895."

Compulsory Dipping Area.

PART VI.—SHEEP AFFECTED WITH TICK OR LICE.

All sheep in South-West Division of the State to be dipped.

54. (1) Unless otherwise authorised by the Chief Inspector of Stock every owner of sheep within the boundaries of the South-West Division of the State shall on or before the 1st day of February in each year dip or cause to be dipped in a swim bath prepared from some specific known to be fatal to ticks and lice all sheep running upon land whereof he is the owner or occupier Provided that, in

the case of sheep in the Armadale, Murray, Harvey, Drakesbrook, Bunbury, Dardanup, Donnybrook, Balingup, Greenbushes, Bridgetown, Warren, Nannup, Capel, Busselton, and Augusta Road Districts, as constituted under "The Road Districts Act, 1919," it shall be sufficient for the purposes of these regulations if the requirements of this paragraph are carried out on or before the 31st day of March in each year.

(2) If any sheep affected with tick or lice shall be found upon any property on which sheep are grazed, the owner or occupier of the land on which the affected sheep are depasturing shall be guilty of an offence against this Act, and any inspector may give notice to the aforesaid owner or occupier of the land on which the affected sheep are depasturing to dip or dress the sheep forthwith in such manner and at such place as the inspector of stock may direct, and every such owner or occupier who refuses, neglects, or fails to comply with the aforesaid notice shall be liable to a further penalty.

(3) No sheep affected with tick or lice shall be offered for sale privately or by auction or removed from the property on which the sheep are being depastured until they have been dipped in some specific known to be fatal to tick and lice, provided that permission may be granted by the inspector to remove them to an approved dipping place.

Sheep infested with Tick or Lice must be dipped.

55. (1) If an inspector is satisfied that stock depasturing in any part of the State is affected with tick or lice, he shall give the owner thereof notice to dip such stock forthwith to the satisfaction of the inspector or his agent.

And any owner who refuses, neglects, or fails to comply with such notice on or before the date specified therein shall be liable on conviction to a penalty not exceeding fifty pounds for the first offence, and if immediately after conviction for the first offence such stock shall not be dipped to the entire satisfaction of the inspector, such owner shall upon conviction be liable to a further penalty not exceeding fifty pounds, and so on for each and every succeeding conviction.

(2) If any sheep affected with tick or lice shall be found in any pound, or in any yard or yards, or on any land or other place at which sheep are offered for sale or exhibited for show purposes, the owner exposing the sheep so affected shall be liable to a penalty not exceeding fifty pounds, and an inspector, if he deems it necessary, may order the withdrawal from sale of any sheep affected with tick or lice until such sheep have been dipped or dressed to the satisfaction of such inspector or any other inspector, and may give notice to the aforesaid owner of such sheep to dip or dress the same forthwith, at such place as the inspector may direct; and every such owner who refuses, neglects, or fails to comply with the aforesaid notice shall be liable to a further penalty not exceeding twenty pounds. But if the inspector is satisfied that such sheep are intended for immediate slaughter, he may withhold such notice to dip.

Stud Sheep.

56. Every owner, occupier, or person in charge of any holding in the South-West Division of the State shall, before the removal of any stud sheep, make a statutory declaration, according to Form No. 8 in the Third Schedule hereto, that such sheep are free from tick and lice. If such sheep are found to be suffering from tick or lice, such owner, occupier, or person in charge shall cause them before

removal to be dipped in a swim bath prepared with some specific known to be fatal to tick and lice, and shall make a declaration, according to Form No. 9 in the Third Schedule hereto, that they have been so dipped.

Statutory Declaration to be supplied within fourteen days after dipping.

57. Within fourteen days after the dipping of his sheep the owner shall make a statutory declaration before a justice of the peace, to the effect of Form No. 10 in the Third Schedule hereto, stating that he has dipped his sheep in accordance with the provisions of these regulations, the date of dipping, the number of sheep dipped, and the class of dip used, and he shall forward such declaration to the Chief Inspector of Stock.

Ewes with lambs—time for dipping.

58. Notwithstanding anything contained in these regulations, it shall not be necessary to dip ewes affected with ticks or lice during such time previous to or after their lambing as the inspectors may appoint, and for such purpose any inspector may, in respect of such ewes, extend any notice to dip for such time as he shall think fit.

Permits to move sheep in the Gascoyne.

59. (1) Every owner of sheep in the area hereinafter defined must, before travelling or removing or causing to be removd, or attempting to remove, any sheep to any place outside the said area, obtain a permit to remove such sheep from an inspector of stock, who shall not issue the said permit unless he is satisfied that the sheep intended to be so removed out of the prescribed area are free from parasites known as tick and lice; and every person contravening this regulation by act or omission shall be punishable summarily, and upon conviction be liable to a penalty not exceeding one hundred pounds and not less than fifty pounds.

(2) The area referred to is that portion of the State bounded on the South by the Northern boundary of the South-West Division, commencing at the sea-coast and proceeding as far as the intersection of such boundary with the 115 degrees 5 minutes East longitude; thence following such meridian Northerly to the intersection of the sea-coast; thence along the sea-coast to the starting point.

Affected Stock not allowed to stray.

60. Every person who by himself, his agent or servant, drives, without the permission of an inspector, or suffers to stray across or upon any land, or drives, depastures, or suffers to stray upon or along any highway any sheep which have not been dipped according to these Regulations, or which are affected with ticks or lice, shall be liable on conviction to a penalty not exceeding Fifty pounds.

THE CLEANSING OF DAIRY UTENSILS.

G. K. Baron-Hay, Superintendent of Dairying.

With the advent of warm weather conditions a rapid falling off has been noticed in the percentage of first-grade creams received at some factories. This is particularly the case where the cream is being drawn from areas from the Great Southern Railway eastwards, and it is interesting to note that the cream being received from these areas has increased approximately 50 per cent. during the last season over the previous year.

It is becoming increasingly difficult to market butter made from such inferior supplies, and factories are being placed in embarrassing positions due to the necessity of handling such cream.

Recent investigations by officers of the Dairy Branch have shown that there are two main causes for the faults in most inferior creams now being received.

(a) Staleness, leading to development of undesirable taints.

(b) Unclean conditions in handling milk and cream.

(a) *Staleness.*—The remedy for this cause is obvious, namely, to forward the cream more often to the nearest factory. Where only a few cows are being milked, and the quantity of cream to be forwarded is small, the temptation to delay despatch till the can may be full is strong, but almost invariably unprofitable.

The loss on only two pounds of butter fat through being graded second grade is not less than 8d., and may be as high as 1s., which is sufficient to pay the railage on the can to the nearest factory. The necessity of frequent consignments has been recognised by the Government in the provision of special concession freight rates on cream over the railways.

(b) *Cleanliness.*—Far more serious defects in cream, however, are caused by unclean methods in handling, and the effect of such conditions very soon becomes apparent in hot weather. It is essential that absolute cleanliness be observed in all dairy work, and the first axiom is to have clean sterile utensils in which to handle the milk and cream.

The only method by which this desirable condition can be obtained is by the provision of adequate washing, and, if possible, steam sterilisation of all equipment. In factories steam sterilisation is always practised, but on farms the necessary boiler machinery is not always possible.

A very cheap, but effective, means by which utensils may be properly washed on farms was published by the National Institute for Research in Dairying in 1923, and is applicable, with modifications, on dairy farms in this State where not more than 20 cows are in milk at once.

In cleansing dairy utensils, three processes are necessary, as washing alone will not thoroughly clean, neither will steaming alone. One is complementary to the other.

1. Washing with warm water to remove curdy portion of sediment on buckets, etc.

2. Washing and scrubbing with hot water containing soda, or some recognised dairy cleansing material.

3. Sterilisation by steam.

To perform the third operation, a very simple "steamer" is described below.

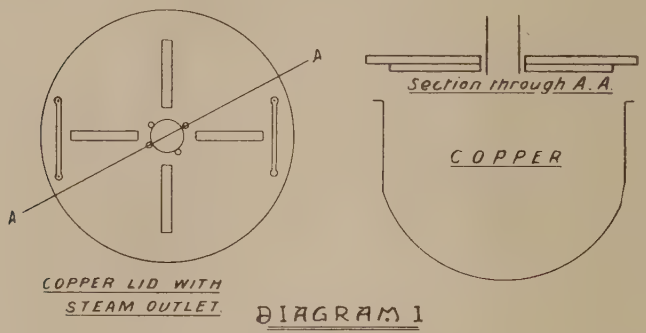


DIAGRAM 1

Drawing by W. A. Hoy, from the National Institute for Research in Dairying.

STERILISATION OF BUCKETS, CREAM CANS, ETC.

An ordinary copper may be used for this purpose in the following way:— A lid which will fit flat on the top of the copper should be made. (See Diagram 1.) A hole about 2½in. in diameter is cut in the centre of the lid, and a metal tube or tin with the bottom removed is fixed in the hole, fitting tightly, so that it projects about 3 inches, and four pieces of thin wood are fixed on the top side of the lid so that the buckets will not rest directly on the flat surface of the lid, and prevent the steam from escaping. It will be found that the steam from an ordinary copper concentrated through the metal tube will effectively sterilise buckets, cream cans, etc. Several small holes, ⅜in. diameter, may be bored in the lid near the tube so as to allow any condensed steam to flow back into the copper.

METHOD OF STERILISING BUCKETS, CANS, ETC.

After the water has been removed to wash the utensils, the copper is replenished and the water made to boil vigorously, the lid having been placed in position. Buckets may then be inverted over the metal tube for sterilisation. Provided the copper is boiling actively throughout the period, the time required to sterilise a 10-gallon can is four minutes; a 5-gallon or less, can or bucket, will require three minutes from the time of placing over the steam outlet. The time may be gauged by the following rough but practically efficient method. It will be noticed that the rim of the can next the lid will be the last part of the bucket to become hot. When this is too hot to be held, a further minute will complete the sterilisation.

The buckets may be laid on their sides, and will rapidly dry. *On no account should an attempt be made to dry the inside of the cans, etc., with a rag.* After the lids have been churned they should be placed on their cans. Buckets should be placed in the dairy free from dust ready for use.

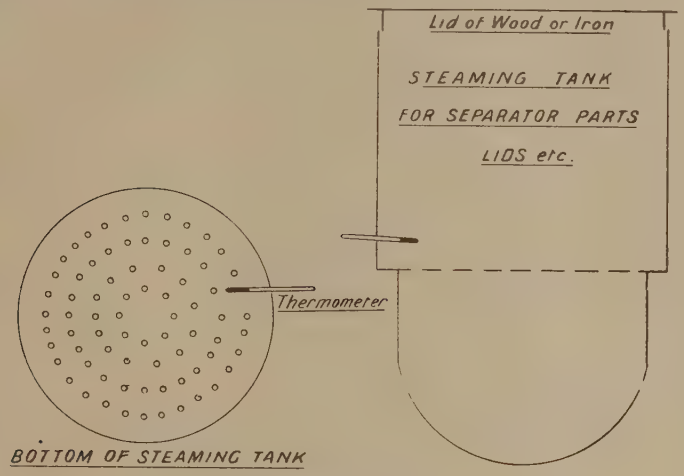


DIAGRAM 2.

Drawing by W. A. Hoy, from the National Institute for Research in Dairying.

STERILISATION OF SEPARATOR PARTS, STRAINER, ETC.

For these utensils a box or tank which will fit over the top of the copper will be required. An ordinary round galvanised water tank will suffice, the diameter being slightly wider than that of the copper, so that the copper will be covered when the tank is placed over it. A well fitting lid of wood or iron will be required for the tank, and two handles should be provided for lifting when hot. The bottom of the tank must be perforated with a number of 1in. holes to allow steam to gain access to the tank. The size of the tank should be sufficient to take the utensils to be treated, but a large tank is undesirable. (Diagram 2.)

The steaming of all utensils which cannot be done over the steam pipe can be done in the tank. The steaming period will vary according to the quantity of material to be heated in the tank, and also by the rate at which the water boils, so it is desirable to insert a thermometer through the side of the tank, taking care that it does not protrude over one of the holes in the bottom, or a higher temperature will be recorded than is that of the tank.

When the thermometer records 210deg. F. (just below boiling point of water), a period of fully five minutes will be required for sterilisation. When the water in the copper boils vigorously, a period of about 10 minutes will be required to bring the tank and its contents up to 210 degrees.

The writer is convinced that by the adoption of one of the methods of cooling cream suggested in the *Journal of Agriculture*, Vol. 7. No. 4, December, 1930, and the sterilisation of all dairy utensils at least once a day when in use, the production of choice cream will become an accomplished fact on not only dairy farms in the cooler portions of the State, but also on the Wheat Belt, where during the summer months the bulk of the cream being produced has developed undesirable flavours by the time it reaches the factory.

THE APPLE TREE AND ITS FOOD.*

Geo. L. Sutton, Director of Agriculture.

During the past 40 years a large amount of research has been carried out in connection with the study of the principles which underlie the nutrition of fruit trees. During the first 30 years the work undertaken was mainly by field experiments modelled on the type adopted by Lawes and Gilbert in their investigations in agricultural crops at Rothamsted.

The results of the numerous earlier experiments—largely American—designed to ascertain in what manner fruit trees would respond to the application of commercial fertilisers, unlike those carried out with agricultural crops, were singularly disappointing and often contradictory.

Pot experiments, designed to study deficiency effects upon the tree and its crop, were initiated by Wallace at Long Ashton, and are still being carried out there, at East Malling and elsewhere; these are giving horticultural workers a much clearer idea of the underlying principles of fruit tree nutrition.

W. H. Alderman, in a paper entitled "The Status of Orchard Fertilisation Experimentation" in 1919 stated, *inter alia*:—

"There are apparently a great many orchards growing upon a variety of soils that will not respond economically to the application of any form of commercial fertiliser, nor of manure. This fact is well established by the work in New York, New Hampshire, Maine, West Virginia, and other States.

"Orchards under starvation conditions usually give a ready response to fertilisation when other treatments (culture, pruning, spraying, etc.) remain unaltered. This is well demonstrated by some of the Ohio, Oregon, and West Virginia experiments.

"Nitrogen in a readily available form seems to be the only element of plant food that is uniformly a factor in favourable responses when such are secured."

The first conclusion of Alderman that there are a great many orchard soils which do not respond economically to the application of any form of commercial fertiliser is to some extent supported by the results of a field experiment with blocks of manured and unmanured apple trees conducted at East Malling Research Station for eleven years commencing in 1919. The results show that the effects of the gradual depletion of plant food by the annual withdrawal of that required by the tree and its crop are not at once apparent, for in reporting upon the respective condition of the two blocks the investigator states:—"As has been pointed out, at the time of planting the trees in the starved (unmanured) plot were, if anything, somewhat sturdier than those in the fully manured plot and during the next five years season's growth the only differences in vigour of which it is possible to be certain are in favour of the unmanured plot."

Such results, which are, no doubt, in line with those of many W.A. orchardists, illustrate the difficulty of obtaining information regarding the effect of fertilisers upon fruit trees by means of short term field experiments. They may also cause some orchardists to form the conclusion that manuring good orchard land is unnecessary. It is believed that such a conclusion is erroneous and requires to be

* An illustrated lecture given at a meeting of Bridgetown Fruit Growers' Association, 5th December, 1931.

guarded against. It is true that the effects of the gradual depletion of plant food are not at once apparent, but it is none the less real, for the tree cannot grow or produce fruit without using some of the plant food in the soil, and experiments conducted at Long Ashton and East Malling in connection with "Leaf Scorch" show how unwise and unbusinesslike it is to allow the depletion of plant food to go on until its effect is noticeable. "Leaf Scorch" is a disease now known to be due to a potash deficiency, and though heavy potash fertilisation was applied to remedy it, it was not until four years or more after the first application that any improvement was noticed, and even ten or twelve years later the trouble may not be entirely corrected.

From the work done and the mass of experimental data collected, certain conclusions have emerged and are available for the guidance of the practical orchardist in W.A. These are:—

1. That on naturally fertile land there is a lack of an immediate response to the application of fertilisers.

2. That it is important to keep the orchard land in "good heart," *i.e.* in good tilth and capable of producing reasonably good cover crops.

3. That it is important to apply potash fertilisers even when, with our present knowledge, there is no apparent indication of a potash deficiency.

Apart from cultural methods, obviously therefore a fundamental feature of successful horticultural practice will involve a fertiliser programme which aims

(a) to remedy any natural plant food deficiencies in the soil at the time of planting, and

(b) to add to the soil such nutrient constituents as may be removed by the fruit and tree growth.

It may further involve the application of additional fertilisers in order to secure satisfactory or indeed maximum growth of cover crops, which in Western Australian orchards are essential to secure the maintenance of tilth, and to prevent the possible winter leaching of nitrogen.

In common with other agricultural plants, the apple tree and its fruit contains a very large percentage of water. It is regretted that no Western Australian or Australian analyses have been obtained, but according to Roberts* the amount of water in American apples amounts to 85.3 per cent. and rather less, 83.1 per cent., in German apples. Of the 14.7 per cent. dry matter found in the American apples, there is .13 per cent. of nitrogen and .39 per cent. of ash, a total of .42 per cent. only obtained from the soil, the balance being formed mainly from the carbonic acid gas in the air by means of the process known as carbon assimilation. The elements essential for the growth of plants are seventeen in number and are:—Hydrogen, oxygen, carbon, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, iron, manganese, silicon, aluminium, iodine, boron, copper and zinc. Of these the first three are obtained from the air, of which there is an abundance over every orchard, good or bad, and from these some 96.5 per cent. of the dry matter is formed. The constituents containing the remaining fourteen elements are derived from the soil, which therefore provides only about 3.5 per cent. of the dry matter found in the apple. Though these elements provide such a small quantity they are all important and each is indispensable to the tree, for if one is deficient the others do not function properly, and the tree is unable to thrive.

* The Fertility of the Land—I. P. Roberts, 1897.

Fortunately, however, the orchardist, working under normal conditions, need only consider three of these elements, viz., nitrogen, phosphorus, and potassium, as important in connection with his fertiliser practice. The others are usually found in such abundance in the soil or in combination with one or more of the other constituents supplied by commercial fertilisers that the food requirements of the plant are met without special application to supply them. Indeed, until recently the last-named seven were not regarded as necessary for the well-being of plants, and their need has only been discovered consequent upon the more delicate tests now possible being applied. Of this group manganese has probably received the most attention in this State. In 1927 Carne* drew attention to the deficiency of available manganese in certain soils in the Dwarda district of this State, and in consequence of which the oat and wheat crops growing upon them suffered from a disease known as "Grey Speck." Other recent researches in Europe, the United States, and South Australia have shown that manganese is an essential element for plant growth, and the lack of available manganese is found to be a factor in causing plant disease and to be responsible for poor crop yields on certain types of soil. Schreiner† reports that in the swamp districts of Florida, known as the "Everglades," it was originally impossible to grow tomatoes on these soils with the application of commercial fertilisers only and unless a dressing of stable manure brought from outside the area was also applied. It was ascertained recently that the imported stable manure was supplying a deficient element, manganese, and now the application of soluble manganese in the form of sulphate of manganese cures the trouble, leads to the production of normal crops, and has rendered unnecessary the application of stable manure.

As far back as 1923 Wickens‡ obtained evidence that, under some conditions, copper was essential to the welfare of citrus trees. Since then copper has also been found essential for citrus and other fruit trees in New South Wales and U.S.A.

In this State it is customary to state the percentages of nitrogen, phosphorus, and potassium contained in manures and commercial fertilisers as nitrogen, phosphoric acid, and potash, and also in some cases to use their chemical symbols in lieu of the names, thus N for nitrogen, P_2O_5 for phosphoric acid, and K_2O for potash.

In Table 1 will be found the percentages of nitrogen, phosphoric acid, and potash found in the apple tree and fruit as given by Roberts.§ The difference between the analyses of American and German fruit will be noticed at once, and though it is considered that the American figures will the more nearly approximate Australian, it is obvious that the analyses must be regarded and discussed in a wide and comparative, rather than in a restricted, manner. The striking features of these analyses are the relatively large proportion of potash in the fruit and similarly the relatively large proportion of nitrogen in the leaves. This latter may account for the consistent response to nitrogenous fertilisers referred to by Alderman and already quoted.

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* Journal Agric., W.A., December, 1927—"Grey Speck Disease of Wheat and Oats."—W. M. Carne.

† Some New Factors in Fertilizer Practice—O. Schreiner, "The American Fertilizer," July 5th, 1930.

‡ Exanthema of Citrus Trees—G. W. Wickens. The Proceedings of the Imperial Botanical Conference, London, 1930.

§ The Fertility of the Land—I. P. Roberts, 1897.

Table 1.

Percentages Water and Fertiliser Constituents Found in the Apple Tree and Fruit (Roberts).

Part of Plant.	Water.	Ash.	Nitrogen (N).	Phosphoric Acid (P_2O_5).	Potash (K_2O).
	%	%	%	%	%
Leaves (Spring)	72·3	2·33	·74	·25	·25
„ Autumn	60·7	3·46	·89	·19	·39
Fruit (American)	85·3	·39	·13	·01	·19
„ (German)	83·1	·22	·06	·03	·08
Branches	83·6	·65	...	·04	·04
Trunk	51·7	1·17	...	·06	·06
Roots	64·7	1·59	...	·11	·09
Whole Plant	60·8	...	·35	·05	·17

The average amounts of nitrogen, phosphoric acid, and potash removed annually by 250, 500, and 1,000 cases per acre respectively, calculated from the data for American apples are shown in Table 2. As the weight of the leaves and branches produced annually by trees bearing these crops are not available, it has not been possible to make calculations of the amounts required for these portions of the tree. Roberts has, however, estimated the amounts which had been removed

Table 2.

Estimated Average Yearly Fertiliser Requirements for Crops of 250,500 *and* 1,000 *bushel cases.*

	No. of Cases—			No. of Cases—			No. of Cases—		
	250	500	1,000	250	500	1,000	250	500	1,000
	Nitrogen.			Phosphoric Acid.			Potash.		
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Fruit	13	26	52	1	2	4	19	38	76
Leaves	...	23	...	...	7	...	...	22	...
Branches	...	14	...	...	6	...	...	13	...
Total	...	63	...	...	15	...	...	73	...

by the leaves and branches of trees during 20 years, these trees then bearing about 500 bushels per acre. These figures have been taken as representing those relating to a crop of 500 bushels, and are included in the table. Though a crop of this size is far greater than the average Western Australian crop, it is not an impossible one, and as it is the only one for which data are available, the fertiliser requirements of the Western Australian crops will be considered on this basis. From the figures in Table 2, it is estimated that the annual requirements of a 500-bushel crop are:—Nitrogen, 63 lbs.; phosphoric acid, 15 lbs.; and potash, 73 lbs.

In addition to the plant food removed by the apple tree and its crop, there have to be considered also the possible losses due to the essential cultural methods of good orchard practice. The work of the Rothamsted Experiment Station furnishes interesting information on this point. At that station is was found that from a piece of land five feet deep which, though kept free from weeds, was not cultivated, there was an annual loss during 23 years of nitrate nitrogen equal to,

per acre, from 15 to 60 lbs. This was leached out and found in the drainage waters.* The loss of this nitrogen was possible only because of the decomposition of the organic matter (humus) in the soil from which it was formed. The ground from which the loss occurred was uncultivated. Had it been cultivated, the losses would have been greater, because the natural agencies responsible for the decomposition of the humus would have been assisted by the greater aeration of the soil due to the cultural methods. Evidence on this point is furnished by studies on fallowed land in our Wheat Belt. It has been found on this land that much larger quantities of nitrate nitrogen accumulate in the soil during the spring and summer, hence there must have been a much greater destruction of organic matter than is the case at Rothamsted.

Good orchard practice in Western Australia involves clean cultivation during the summer, and it is obvious, therefore, that the destruction of the organic matter in the soil must proceed at practically a maximum rate. With warm weather and intense cultivation the organic matter is literally burned out. As the quantity of organic matter in the soil is lessened, its ability to withstand drought is reduced, and the difficulty of maintaining tilth of the heavier soils is increased. The organic matter is also the food for the soil bacteria which render available the food necessary for tree growth. It is, therefore, as **important to replace in the soil the organic matter destroyed by cultivation as it is to return the plant food utilised and removed by the tree and its crop.** This can be done readily by green manuring, *i.e.*, the growth of cover crops during the autumn and winter, and ploughing them or their residues in during the early spring. Such crops need not necessarily be sown ones, and in most cases will not be. The natural vegetation which springs up in the orchard when cultivation ceases and the autumn rains commence will usually supply all that is necessary for the purpose. If, however, this growth does not contain some legumes such as clovers and trefoils, and also some deep rooting plants, then seeds of these plants should be sown. Leguminous plants are necessary because, as most orchardists are now aware, these plants collect the free nitrogen of the air by means of the colonies of bacteria found in their roots, store it in the leaves, stems and roots, and as these decay in and become incorporated with the soil, its nitrogen content is increased. As a natural consequence a considerable saving in the fertiliser bills is effected. Deep rooting plants are advisable, because these will open up and aerate the subsoil; they also encourage deep rooting of the tree, for as the roots of the deep rooting cover plants decay the feeding roots of the tree will descend and feed upon the material thus made available. Very suitable plants for this purpose are the "White Mustard" (not wild mustard) and "Rape." The seed of both is comparatively cheap, and the former has the advantage that it is an extremely quick-growing plant, and will probably furnish a greater amount of organic matter in a shorter period than any other cultivated plant.

Though the pasturing of cover crops in the orchard is not advocated because of probable damage to the trees and the danger of the puddling of the heavy soils, it has to be pointed out that even when this is done, the addition of organic matter to the soil is considerable, and in most cases the amount of the three principal fertilising constituents removed by the grazing stock is small, that is, provided the grazing is not spasmodic but continuous, and the excreta resulting from the food eaten is returned to the soil.

The plant food contained in a cover crop is not available for the use of trees or other succeeding crop until it has decayed, and it will dry rather than decay

* The Chemistry of the Farm (20th Edition)—R. Warrington.

if its ploughing is delayed so long that moisture in the soil in which it is buried is scanty or absent. It is, therefore, essential that the cover crop be ploughed in prior to the end of the rainy season, and as soon as it is possible to get on the ground in the spring, say prior to the end of August.

The growth of cover crops, their incorporation with the soil, and the addition of commercial fertilisers to supply the other plant food needs of the tree and its crop will keep the soil in that "good heart" necessary to secure optimum crops of fruit. Because the productivity of the tree is not dependent upon the immediate application of fertilisers as are annual crops, the character of the cover crop may be regarded as the indicator by which the fertiliser needs of the orchard may be judged. Whilst leguminous cover crops grow luxuriantly and potash fertilisers are applied, the signal may be considered to be set at "Safety."

Some of the sources from which the nitrogen requirements of the orchard can be obtained are shown in Table 3. Included amongst these are leguminous crops and farm-yard manure, and before considering the purchase of commercial fertilisers, the possibilities of both of these should receive the attention of the farmer.

Table 3.

Some Sources of Nitrogen and Prices per Ton, W.A., 1931.

Source of Nitrogen.	Composition.			Price per ton.
	Nitrogen.	Phosphoric Acid.	Potash.	
	%	%	%	£ s. d.
Leguminous Crops	·55	...	...	
Farmyard Manure	·36	...	...	
Sulphate of Ammonia	20·5	...	...	13 0 0
Nitrate of Soda	15·5	...	...	15 4 0
Nitrophoska	15·5	15·5	19·0	23 0 0
Diammonphos	20·6	53·0	...	40 0 0
Blood and Bone (A)	5·75	13·0	...	11 5 0
Blood and Bone (B)	6·0	9·0	...	12 10 0
Bonedust (A)	3·5	22·0	...	12 10 0
Bonedust (B)	2·75	18·3	...	10 15 0
Unit Values—P_2O_5, 4/3 ; K_2O, 4/10.				

The percentage of nitrogen shown as being present in leguminous crops is the average of those found in samples of Subterranean Clover collected at the end of August and at the period when a crop of this kind should be ploughed under. Five tons of such a crop would therefore supply about sufficient nitrogen to meet the requirements of the trees producing a 500-bushel crop of apples.

It will thus be seen that a good leguminous cover crop will provide all the nitrogen necessary for the growth of the tree and the production of its fruit.

The number of orchards using mechanical traction is increasing, but still most orchardists keep a cow and some poultry, and at least a little farm-yard manure is available. Whilst, no doubt, the vegetable and flower gardens have the first call upon this, its value in the orchard should not be overlooked. Its analysis shows that a ton contains 8 lbs. nitrogen, 6 lbs. of phosphoric acid, and the same quantity of potash, so that eight tons per acre will supply all the nitrogen requirements, and in addition, very much more phosphoric acid than is required and two-thirds of the potash needed. In addition, considerable further benefits accrue to the soil as the result of the organic matter it contains and possibly, as indicated by the experience in the Florida Everglades, it may also supply some of those trace-like but essential elements like manganese.

The fertilisers referred to in the table are fairly representative of the nitrogenous group on the local market, and it will be seen that there is considerable difference in their nitrogen content which ranges from 2.75 per cent. in the case of bonedust B to 20.6 per cent. in Diammonphos. These two ferilisers also represent the greatest range in price, from £10 15s. to £40. Neither the analyses nor the prices may have any relation to the agricultural value of the fertilisers. This is based upon two factors—the form in which the nitrogen is contained in the fertiliser and its cost per lb. or per unit. Nitrogen in fertilisers is in three forms, viz., organic, ammoniacal, and nitrate. For the purpose now being considered, the main difference between these is that the organic form is slower to act than ammoniacal, and this latter slower than the nitrate. Provided there is ample time in which to apply any one of these forms before its effect upon the tree is required, and usually under Australian conditions this is the case, all forms may be considered to have the same value. The orchard value of the nitrogen may therefore be considered to be in direct relation to its cost per lb. or per unit. A fertiliser "unit" is the conventional term used in valuing the constituents of fertilisers, just as a "stone" of 14 lbs. is a recognised term used in valuing and selling some other commercial commodities. A fertiliser unit is 1/100 or 1 per cent. of 1 ton (*i.e.*, 22.4 lbs.), and is used because the quantity of plant food contained in a commercial fertiliser is usually expressed in percentages, and it is thus very much easier and quicker to determine the value of a unit than that of a lb. In Tables 4 and 5 are shown the methods of calculating the price per lb. and per unit, and from a comparison of these methods it will be seen how much easier is the latter method.

Table 4.

Cost of Plant Food per Lb.

Sulphate of Ammonia, 20·5 %N.—Cost £13 per ton.
There are 20·5lbs. of N. in 100lbs. of fertiliser.

„ „ $\frac{20 \cdot 5\text{lbs.}}{100}$ „ „ 1lb. „

„ „ $\frac{20 \cdot 5 \times 2{,}240\text{lbs.}}{100}$ of N. in 2,240lbs. or 1 ton of fertiliser.

=459·1lbs. of N. in 1 ton of fertiliser costing £13.
459·1lbs. N. cost £13.
1lb. N. „ £13 ÷ 459·1
1lb. N. „ 6·8d.

Table 5.

Valuation of Fertilisers.

Cost of Plant Food per Unit.

One Unit = 1/100 or 1% of 1 ton.
Sulphate of Ammonia, 20·5% N. costs £13 per ton.
20·5 Units in 1 ton cost £13.
1 Unit costs £13 ÷ 20·5
1 Unit costs 12/8

The calculations given relate to a simple fertiliser, sulphate of ammonia, but all the fertilisers supplying nitrogen, and shown in Table 3, are not simple. Nitrophoska, for instance, is a compound fertiliser containing phosphoric acid and potash in addition to nitrogen.

Before the cost of a "unit" of nitrogen can be determined in this or similar fertilisers, it is necessary to deduct from its price per ton the value of the other constituents—phosphoric acid and potash—which the fertiliser also contains. For

this purpose, and in this instance, the unit cost of these ingredients is ascertained from the market prices of the simple fertilisers. Superphosphate and muriate of potash will supply respectively phosphoric acid and potash. The unit values are calculated to be 4s. 3d. and 4s. 10d. respectively for P_2O_5 and K_2O. Using these figures for Nitrophoska, it is found that—

	£	s.	d.
15.5 units P_2O_5, at 4s. 3d., cost	3	5	11
19.0 units K_2O, at 4s. 10d., cost	4	11	10
	£7	17	9

When this total is deducted from £23, the cost of the nitrogen is Nitrophoska is found to be £15 2s. 3d., representing the cost of 15.5 units of nitrogen at 19s. 6d. per unit.

Dealing with the other compound fertilisers in a similar manner, it is found that the relative costs of nitrogen per unit are as follow:—

Sulphate of ammonia—12s. 8d.
Nitrophoska—19s. 6d.
Nitrate of soda—19s. 7d.
Diammonphos—27s. 11d.
Blood and bone (A)—29s. 6d.
Blood and bone (B)—35s. 4d.
Bonedust (A)—44s. 9d.
Bonedust (B)—49s. 11d.

It will thus be seen that the cheapest form in which to buy nitrogen is in sulphate of ammonia, and at a price which is about a quarter that of the most expensive form, Bonedust (B).

Our climatic conditions are favourable to fairly quick nitrification in the spring, and in consequence the organic nitrogen in the soil following the ploughing in of a luxuriant cover crop in *early* spring should be quickly converted into the readily available nitrate form. It is difficult to realise, therefore, that under such conditions there will be any need to supplement the nitrogen supplied by the cover crop with applications of a quick-acting fertiliser.

Some American experiments in connection with the setting of the fruit of apples and pears indicate a possible advantage following a spring dressing of a quick-acting nitrogenous fertiliser. The results are shown in Table 6 hereunder.*

Table 6.

Influence of Nitrate of Soda Applications upon Set of Fruit in Two Hood River (Oregon) Apple Orchards.

——	No. of blossoming spurs.	Percentage of fruit set June 4.	Percentage of fruit set Sept. 30.	Average Yield per tree (bus.)
First Orchard—				
Check (unfertilised)	483	35·3	16·4	3·75
Fertilised with Nitrate ...	542	68·0	30·7	21·50
Second Orchard—				
Check (unfertilised)	386	9·0	4·6	1·33
Fertilised with Nitrate ...	620	58·0	15·1	9·50

* Fundamentals of Fruit Production—Gardner, Bradford and Hooker, 1922.

In view of the American results obtained, and in the absence of any definite Australian data on this point, it is deemed advisable to recommend an application of nitrogen equivalent to 1 cwt. of sulphate of ammounia to be applied so as to be available when the buds are opening. It is suggested that if nitrate of soda (1¼ cwt.) is used that it be applied about a fortnight before the expected date of flowering; if sulphate of ammonia, 1 cwt., about a week earlier, and if blood and bone or some other organic form about another week earlier still.

Some workers have advanced the opinion that with trees which have acquired the habit of biennial bearing, the application of a heavy dressing of nitrogenous fertiliser in the year of heavy bearing will tend to correct the habit for the following year. Whether this opinion eventually proves sound or otherwise, there is no reason to advocate the application of nitrogenous fertilisers to trees in their off-bearing season.

In the results of some experiments carried out by Teakle and Burvill* on fallowed land at the Merredin Experiment Farm in the wheat area, it is shown that the effect of maintaining a clean fallow, as is the case in every well-cultivated orchard, was to have available in the soil in the autumn (19th April) a large amount of nitrate nitrogen. This amounted to 181 lbs., and was nearly equal to the amount supplied by 9 cwt. sulphate of ammonia. Information is not available regarding the amount of nitrate nitrogen produced in the fallowed land of a well-cultivated orchard. It is reasonable to suppose that, in connection with the decomposition of organic matter, a similar position would obtain and a large amount of nitrogen made available. It is to be expected that some would be used by the tree roots so that there would not be such a large accumulation of unused nitrogen as in the case of the wheat fallow, but there would seem to be no need to apply a dressing of nitrogenous fertiliser to the orchard in the autumn provided a good cover crop has been grown the previous year, and opportunities offered for its decay by ploughing in early. The possibilities of quantities of available nitrogen being available in the soil in the autumn do, however, indicate the need for the early growth of a cover crop so as to prevent the leaching of the nitrogen not utilised by the tree roots. Unlike phosphoric acid and potash, nitrogen is not stored in the soil, but is very readily lost.

In Table 7 are shown some of the sources of phosphoric acid, together with their composition and cost.

Table 7.

Sources of Phosphoric Acid—W.A., 1931.

Relative Costs per Ton.

Sources of Phosphoric Acid.	Nitrogen.	Composition Phosphoric Acid.			Potash.	Price per ton.
		W.S.	C.S.	A.S.		
Farmyard Manure	·36	·27	...	...	·27	
Superphosphate, 22%	...	20·5	·5	1·0	...	£4 10s.
Nitrophoska	15·5	15·5	...	...	19·0	£23.
Diammonphos	20·6	53·0	...	...	...	£40.
Blood and Bone (A)	5·75	...	...	13·0	...	£11 5s.
Blood and Bone (B)	6·0	...	...	9·0	...	£12 10s.
Bonedust (A)	3·5	...	...	22·0	...	£12 10s.
Bonedust (B)	2·75	...	...	18·3	...	£10 15s.
Rock Phosphate	...	...	...	36·6	...	£4 11s. 6d
Unit Values—N = 12s. 8d.; K_2O = 4s. 10d.						

*Fallowing for Fertility—Journal of Agriculture, W.A., March, 1930.

Phosphoric acid in manure and fertilisers is found in three forms, known respectively as water soluble, citrate soluble, and acid soluble. The first, as its name implies, is soluble in water, and is the most readily available to plants; the second is soluble in weak acids, and has almost the same agricultural value; the third is very much slower in action, its availability for the plants' use depending upon its fineness of grinding in the case of the mineral or rock phosphate, and the rate of decay in the case of the organic fertilisers, bonedust and blood and bone.

The principal phosphatic fertiliser in Western Australia is superphosphate, and this is valuable mainly because of its water soluble phosphoric acid; the unit value of this has been determined by ascribing an arbitrary value of 1s. per unit to the acid soluble phosphoric acih and to the citrate soluble phosphoric acid 80 per cent. of the value of the water soluble form. The unit value of the phosphoric acid in other fertilisers was determined as in the case of nitrogen contained in compound fertilisers. As the result of these calculations, the following are found to be the relative costs per unit:—

Rock phosphate—2s. 6d.
Superphosphate, 22 per cent.—4s. 3d.
Bonedust (A)—9s. 4d.
Bonedust (B)—9s. 10d.
Diammonphos—10s. 2d.
Nitrophoska—11s. 1d.
Blood and bone (A)—11s. 8d.
Blood and bone (B)—19s. 4d.

It is quite possible that, for the nutrition of the fruit trees, the slower acting forms of phosphoric acid, even that of the rock phosphate, if very finely ground, would be satisfactory; but as has been pointed out, the growth of the winter cover crop is an *all important* feature of orchard practice, and quite as an important a feature as the application of the fertiliser itself, and therefore the suitability of the fertiliser for promoting the growth of the cover crop is of prime importance.

Superphosphate has proved an excellent fertiliser for producing maximum results with leguminous cover crops in the orchard districts of the State. It can therefore be regarded as a very suitable orchard fertiliser for supplying phosphoric acid. It has the advantage that it is much cheaper, the relative unit cost being less than half that of the cheapest of the other soluble forms and less than one quarter the cost of the most expensive and slower acting form, blood and bone (B).

Though it has been calculated that about 75 lbs. of superphosphate will supply the phosphoric acid needs of an acre of apple trees producing a crop of 500 bushels, it is believed that this amount will hardly be sufficient to ensure maximum results with a leguminous cover crop, and hence it is recommended that this amount should be increased to whatever quantity experience or trial indicates is desirable. This is likely to be at least 1 cwt. per acre and in some cases 2 cwts., or even more. It should be applied in the early autumn. These amounts of superphosphate will also supply the additional amount of phosphoric acid indicated as desirable by the German analyses of fruit as given in Table 1.

Though the phosphoric acid is the water soluble form, there need be no fear that it will be washed out. When superphosphate is applied to the soil the water soluble phosphoric acid it contains is washed into the soil by the first rains, after which a reaction takes place, and it is precipitated in a very fine state of division

and throughout the soil. Though available for the use of the plant, it is not leached out, but, as was found at Rothamsted, any surplus not used by the plant accumulates in the layer of soil stirred by the plough.

At this stage it is opportune to refer to the question of lime. It may be asked "What is the need for lime in the orchard?" To this it can be replied that there is no need to apply lime in order to meet the plant food requirements of the fruit. From Table 1 it will be seen that about .4 per cent. of the fruit is ash, the average of four South African analyses (Thorpe's Dictionary of Applied Chemistry) show that about 2 per cent. of the ash is lime, so that on this basis there will be less than 2 lbs. of lime in 500 bushels of fruit. Wickson, in "California Fruits," gives the percentage of lime in the ash as 4.08 per cent., so that, taking this higher figure, the amount of lime in 500 bushels of fruit will be about 4 lbs. This quantity is more than supplied in every cwt. of superphosphate or bonedust applied to the soil. In the superphosphate there would be about 9 lbs. of lime in the form of a soluble monocalcic phosphate, or about three times the quantity in bonedust. As a soil corrective, even the larger amount would have little or no effect, nor would the greater quantity combined with sulphuric acid forming gypsum. For the purpose of improving the tilth of heavy and unkindly soils or for correcting acidity, a dressing of lime may be desirable, but even for these purposes, under our climatic conditions, some doubt was raised by Wenholz* in his paper before the Australasian Association for the Advancement of Science in 1923. He stated that "lime undoubtedly has the effect of opening up and lightening stiff clay soils, but it is also doubtful here whether its use can be unhesitatingly recommended in all cases. Deep thick-rooting crops and the subsequent decay of these roots in the soil, or the use of organic matter of animal or vegetable matter may be sufficiently effective at less cost. Soils which have been for some time under cultivated crops have lost a considerable amount of their organic matter, and have a greater tendency to run together easily and bake after rain, yet the addition of organic matter by some systematic rotation with pasture, grazing fodder crops with stock or animal or green manuring is known to be a simple and effective expedient in many cases to remedy this physical defect without the costly application of lime."

From Table 8 it will be seen that the unit values for potash in the respective fertilisers are—

Muriate of potash—4s. 10d.
Sulphate of potash—5s. 11d.
Nitrophoska—10s. 5d.

Muriate of potash is relatively the cheapest, and though it also contains common salt, which renders it unsuitable for best results with potatoes, it is quite suitable for orchards. The potash requirements of the trees and crop of 500 bushel cases per acre have been estimated as 75 lbs. This amount is supplied by 150 lbs. muriate or sulphate of potash. As the muriate is the cheaper and is suitable, this form should be used. The potash fertiliser should be applied with the superphosphate in the early autumn in order to stimulate to the fullest extent the growth of the cover crop, whether natural or sown. Though the potash is readily soluble in water, it forms compounds in the soil, and as the experiments at Rothamsted have shown, it does not leach away, but is held in the soil until absorbed by the feeding roots. The common salt, on the other hand, readily leaches out of the soil with the first heavy rains.

*Some recent views on the Liming of Soils—H. Wenholz, "Agricultural Gazette," New South Wales, January, 1923.

Table 8.

Some Sources of Potash and Cost per Ton—W.A., 1931.

Sources of Potash.	Potash.	Price per Ton.
		£ s. d.
Farmyard Manure	·27	...
Wood Ashes	·6 to 6	...
Sulphate of Potash	48·6	14 6 6
Muriate of Potash	50·4	12 1 6
Nitrophoska*	19·0	23 0 0

* Contains also N and P_2O_5 with unit values—

P_2O_5 ... 4s. 3d.

N. ... 12s. 8d.

It will be seen that in Table 8 wood ashes is also given as a source of potash. The percentage is variable, depending upon the timber from which they are obtained. Though the percentage of potash in them is sometimes low, they should not be wasted for they also contain small quantities of phosphoric acid and lime. To save what are available is part of the economy of the farm. The plant food in them is in a very soluble form, and if exposed to rain it will quickly leach into the underlying soil, and leached ashes are of very little value. It is, therefore, necessary to keep the ashes dry whilst they are being conserved prior to their application to the orchard soil.

In Tables 3, 7, and 8 have been given the analyses and costs per ton of some of the various fertilisers on the local market. As already explained the method of calculating the unit value of a single plant food constituent in the compound fertilisers in those tables has been to deduct the value of the other constituent or constituents from the total cost and divide the balance by the number of units of the particular constituent under consideration. The value of the other constituents has been based upon the cheapest rate at which these could be obtained in simple fertilisers. This method was adopted to show the relative costs of single constituents in compound manures, and is satisfactory if the comparison is made with regard to one constituent only. It is, however, unsatisfactory and unfair to evaluate a compound fertiliser from the unit values of its two or three constituents found in this way, for any difference between the unit values of the simple fertilisers and those of the compound fertilisers is exaggerated.

Obviously, a compound or mixed fertiliser is to be valued with regard to all its constituents; then any difference between its cost and the amount for which the same constituents can be purchased in simple fertilisers should be spread proportionately over all the fertilising constituents it contains. Thus, in the case of blood and bone (A), the same amount of nitrogen (5.75 units) can be supplied by sulphate ammonia at 12s. 8d. per unit for £3 12s. 10d., and its phosphoric acid (13 units) by superphosphate at 4s. 3d. per unit for £2 15s. 3d., or both constituents for a total of £6 8s. 1d. The cost of the blood and bone is, however, £11 5s. per ton, or an increase of 76 per cent.; when this increase is spread proportionately over both constituents, it is found that the 5.75 units of nitrogen cost £6 8s., and the 13.00 units of phosphoric acid cost £4 17s., making the total cost per ton £11 5s. Accordingly, the unit cost for nitrogen is 22s. 4d., and for phosphoric acid is 7s. 6d.

Similarly the unit costs of the constituents of the other compound fertilisers have been found and these, with those of the simple fertilisers are set out in Table 9 hereunder:—

TABLE 9.

Unit Costs of Fertilisers.

Proportionately distributed in the case of Compound Fertilisers.

	N.	P_2O_5.	K_2O.
	£ s. d.	£ s. d.	£ s. d.
Blood and Bone (A)	1 2 4	0 7 6	
Blood and Bone (B)	1 7 9	0 9 4	
Bonedust (A)	1 2 11	0 7 8	
Bonedust (B)	1 4 2	0 8 1	
Diamonphos	1 0 11	0 7 0	
Nitrophoska	0 16 6	0 5 6	0 6 3
Sulphate of Ammonia	0 12 8		
Nitrate of Soda	0 19 7		
Rock Phosphate	..	0 2 6	
Superphosphate	..	0 4 3	
Muriate of Potash	..	..	0 4 10
Sulphate of Potash	..	..	0 5 11

The extra cost per unit of the fertilising ingredients in compound or mixed fertilisers is sometimes entirely offset by the convenience and ease of application attached to the use of such a fertiliser.

In Table 10 will be found figures showing the comparative costs of the fertilisers used on a 10-acre orchard in accordance with the scheme which has been outlined when a cover crop is grown, and when 100 and 200 lbs. per acre of superphosphate are used with the cover crop. It will be seen that in both cases when the fertilisers are purchased at the lowest unit rates ruling in the market, the cost is less than one-third of that necessary when they are purchased at the highest rates.

Table 10.

The Apple Tree and Its Food.

Relative Fertiliser Costs for 10-acre Orchard.

Constituent.	Amount.	Cost. Lowest Unit Rate.	Cost. Highest Unit Rate.	Amount.	Cost. Lowest Unit Rate.	Cost. Highest Unit Rate.
		£ s. d.	£ s. d.		£ s. d.	£ s. d.
N	200	5 14 0	19 4 9	200	5 14 0	19 4 9
P_2O_5	220	2 2 6	10 5 0	440	4 5 0	20 10 0
K_2O	750	8 2 0	17 9 0	750	8 2 0	17 9 0
	...	£15 18 6	£46 18 9	...	£18 1 0	£57 3 9

Similarly, in Table 11, the relative costs are shown when the whole of the nitrogen requirements are purchased consequent upon no cover crop being ploughed in. From these figures it will be seen that the growing of a cover crop saves the orchardist about £1 2s. per acre on the lowest scale. In both cases the difference between the expenditure at the highest and lowest rates respectively is so great that the need for buying in the cheapest way is emphasised. This is the point it was desired to make. With this object in view the relative costs have been based upon the highest and lowest unit values obtained in connection with single fertiliser constituents. It is believed that in practice such a wide range could never occur because when buying the highest rates have been used from various compound fertilisers, and no orchardist could buy fertilisers on this basis. The difference between the lowest and highest rates at which the different fertilisers can be bought is significant enough, however, to require that the orchardist shall take every care to purchase his fertiliser requirements at the cheapest possible rates.

Table 11.

The Apple Tree and Its Food.

Comparative Costs, 10-acre Orchard.

Constituent.	Amount Supplied.	Lowest Rate.	Highest Rate.	Amount Supplied.	Lowest Rate.	Highest Rate.
		£ s. d.	£ s. d.		£ s. d.	£ s. d.
N	600	17 2 0	57 14 3	600	17 2 0	57 14 3
P_2O_5	220	2 2 6	10 5 0	440	4 5 0	20 10 0
K_2O	750	8 2 0	17 9 0	750	8 2 0	17 9 0
	...	£27 6 6	£85 8 3	...	£29 9 0	£95 13 3

Summed up, the recommendations in connection with fertiliser practice for apple and pear orchards in Western Australia are:—

1. Grow cover crops containing legumes and deep-rooting plants.

2. Ensure maximum growth of cover crops by manuring early in autumn with—

   Superphosphate, 1 to 2 cwt. per acre, and

   Muriate of potash, 1 to 1½ cwt. per acre, as required to replace the quantity removed by the fruit crop.

3. Plough the cover crops in, whilst the ground is moist and the plants are succulent, as soon as possible after the middle of August.

4. Provide 20 lbs. nitrogen per acre for trees when the buds are open by applying—

   1¼ cwt. nitrate of soda, 2 weeks before flowering, or

   1 cwt. sulphate of ammonia, 3 weeks before flowering, or

   3-5 tons farm-yard manure, 4 weeks before flowering.

When a good cover crop has not been ploughed in, apply more nitrogenous fertiliser, up to three times the amounts mentioned above, the actual amount depending upon the quantity of cover crop ploughed in.

STANDARDISING THE APPLE PACK.

A. Flintoff, Orchard Supervisor.

Mr. W. M. Carne, of the Commonwealth Council for Scientific and Industrial Research, in reporting on the condition of Australian fruit exported during the season 1931, states, with particular reference to apples—

> "I am convinced that many of the defects found in the fruit in London were due to packing and handling. Growers ought to see that the fruit was more carefully packed and graded, thus enabling better resistance to careless handling, which resulted, at present, in bruises."

The following statements were endorsed at a recent important conference of fruitgrowers:—

> "There are too many 'styles' in the packing of fruit for commercial purposes, and the sooner growers realise the importance of putting into universal practice a uniform 'pack' the better it will be for the stabilisation of prices, and the satisfaction of growers, dealers, and consumers alike."

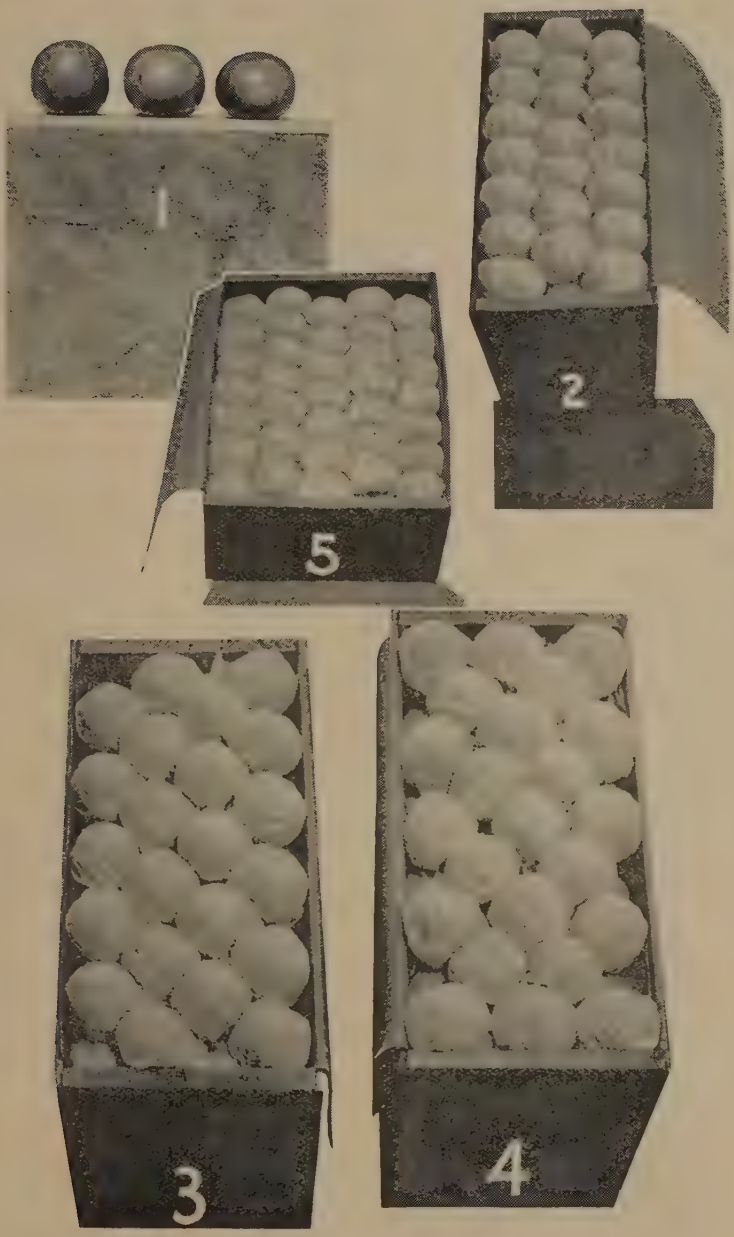
The above statements are considered sufficient apology for making some observations and introducing some modifications concerning the "packs" in general use. Undoubtedly, there is a tendency for some growers to drift into certain methods of fruit packing which appear to them to suit the occasion. This may be quite alright if there was need only to satisfy themselves or those of a like mind.

The dealer in fruit has long since realised the prime advantage of a standard "pack" as, by securing uniformity, he knows just what to expect in the way of bruises due to packing. For example, if a dealer finds that a certain arrangement of fruit in a case gives him, after the average usage in transit, a reasonably pressure free, but firmly packed product, he would naturally desire that all supplies be under the same conditions, but if, on receiving, say, a consignment of 2½ inch apples with several cases packed one way, and several another some showing much bruise through over pressure, and some bruised through being too loosely packed, he is not in a position to guarantee the fruit to a customer—thereby confidence may be lost and trade adversely affected. Obviously, the growers, good and bad alike, would ultimately suffer loss. On the other hand, if each grower is satisfied that the "pack" he has chosen invariably meets the demands of the critical dealer and consumer, and that the method is universally acknowledged to be the result of sound research, then he may be sure that the industry will not suffer loss, but has the best chance of stabilisation. It is agreed, however, that other important factors must be observed in connection with a standard "pack." Fruit must be clean, well developed, and carefully picked, but it is not the purpose of this paper to detail any matter except that dealing with packing.

THE CASE.

As the measurements of the container, or case, have a direct relation to a satisfactory "pack," a few remarks on the subject may not be out of place here. The case used almost exclusively in Western Australia for the export of apples, is known as the Australian dump bushel case, the inside measurements being—length 18 inches, width 8¾ inches, depth 14¼ inches; cubical contents, 2,223 inches.

As two-thirds of an inch is not shown on the ordinary two-foot rule, it may be of interest to note that five-eighths of an inch is nearest to it, being one twenty-fourth of an inch less than two-thirds inch.


1
2
5
3
4

As there is little or no shrinkage of timber "endways," the cubical capacity of the case is controlled by the end boards which have a tendency to shrink side ways. As shrinkage is variable according to the age of timber, it is frequently found that cases are not uniform when required for packing; therefore, the packer should be aware of the difference in widths of cases, to be in a position to pack out with the degree of nicety essential to first-class packing. It is obvious that a case measuring 8½ inches wide will not allow the fruit to "spread" to the same extent as in one 8¾ inches or wider. It is here suggested that the packer should be provided with a measure to test the width of a case before packing, as he would then know just what "pack" would be most suitable.

THE BENCH.

A bench is usually reckoned to be not more than three feet high in front, 3 feet 6 inches at back, and 3 feet 6 inches wide—a board along the front six inches high and one of 1 foot 6 inches at back. A bench 14 feet long should accommodate 25 cases of fruit. From this it may be calculated what bench room would be required to avoid congestion at peak periods in harvest time.

THE PACKING TROLLY.

Growers are familiar with the four-wheeled trolley in general use. It is built to hold the case and paper conveniently for the packer, and no hard and fast rule can be laid down concerning the relative positions of case, paper, and fruit. The packer should be the best judge of this, some preferring a much steeper slope to the case than others. The operator is advised to see that his case is placed before him so that the inside is easily accessible and that the fruit and paper are within easy reach, always realising that with, say, 10,000 apples singly handled in a day, any unnecessary movement with each fruit would, in the aggregate, mean an appreciable loss of time.

THE CORRUGATED CARDBOARD.

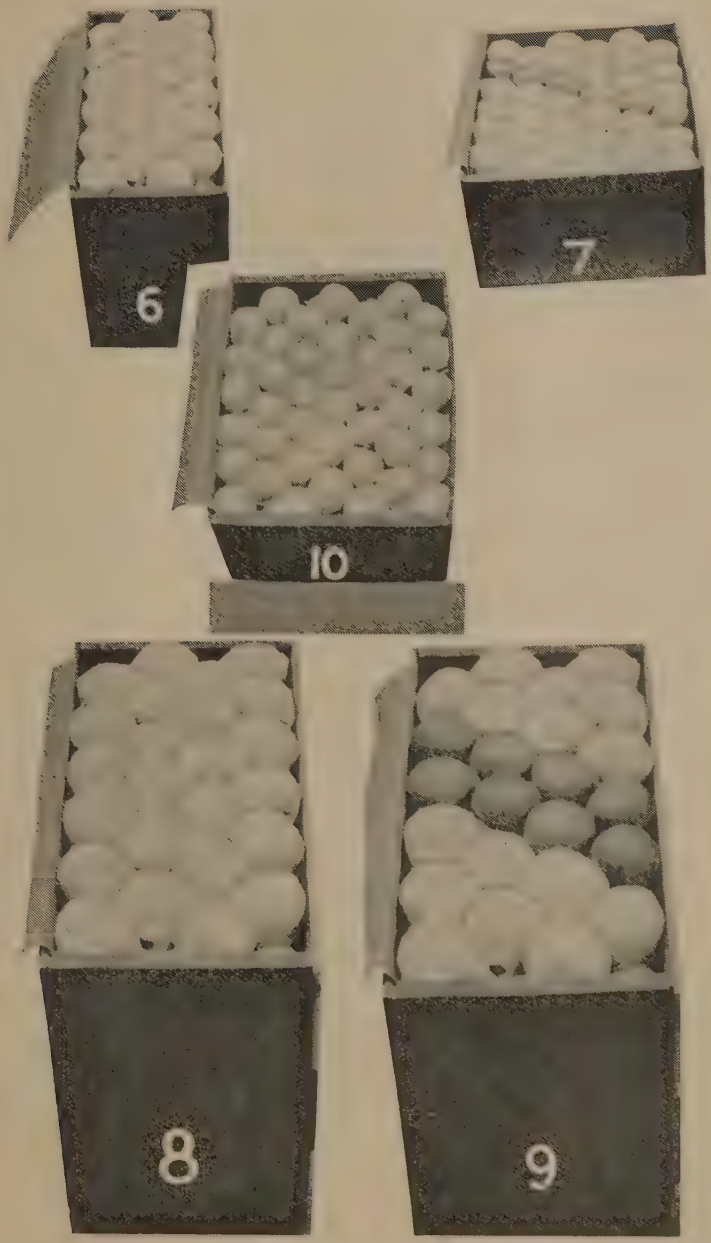
Originally wood-wool was used to form a pad on the bottom of the case, and also on the top of apples at the finish of the "pack." Of later years corrugated cardboards have taken the place of wood-wool. The most recent adaptation of the card-board, where fruit is packed for distant markets, is to line the case entirely. This method has found favour with the trade, as it is claimed that case bruise is thereby minimised. The smooth face of cardboards should be to the fruit.

WRAPPING PAPER.

So well known is the practice of wrapping fruit in specially prepared paper that little need be written in this direction; suffice to say that the papers should be of such a size as to completely cover the fruit. The usual proportions observed are—

2	inch apple—8	inch x	8	inch paper
2¼	inch apple—9	inch x	9	inch paper
2½	inch apple—10	inch x	10	inch paper
2¾	inch apple—11	inch x	11	inch paper
3	inch apple—12	inch x	12	inch paper

The glazed surface of paper should be outwards. Oiled wrapping paper is frequently used in the packing of "Granny Smith" apples for late keeping, as its use minimises what is termed "Granny Scald."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METHOD OF WRAPPING.

Half a dozen packing sheds may be visited, and as many variations in wrapping an apple be seen. This, of course, is of minor importance, provided all undue movement is eliminated and the fruit is properly covered. Generally the expert packer will take up the paper, place it over the apple (first movement): then with a quick movement of both hands and wrist (second movement) efficiently cover the fruit and hold it in the right hand in the correct position for placing in the case. Too careless a wrap is to be avoided, and an over-neat wrap is unnecessary in commercial packing.

Having the foregoing preliminaries satisfactorily arranged, the packer must now consider the method of arrangement of fruit in the box. The first objective is to master the grading, to know in fact, without reference to a measure, what is the diameter of any apple that may be picked up, the diameter or "grade" of an apple being the distance in inches from cheek to cheek across the core. No amount of instruction, without practice, will effect this.

The aim of every packer should be to see that he is in a position to state definitely the arrangement and "count" of any grade of apple. To do this requires a knowledge of the various "packs" and "counts" suited to different "types" of apples.

TYPES OF APPLES.

If Nature had provided a one shape apple covering all varieties, the arrangement of the fruit in the case would be much simplified, as we could set down a definite "pack" similar for each variety in the same grade. On broad lines, the "types" may be divided into three sections, namely, long, medium, and flat. Illustration 1. These apples are all of one grade, yet quite obviously, of varying lengths measured from calyx to stem.

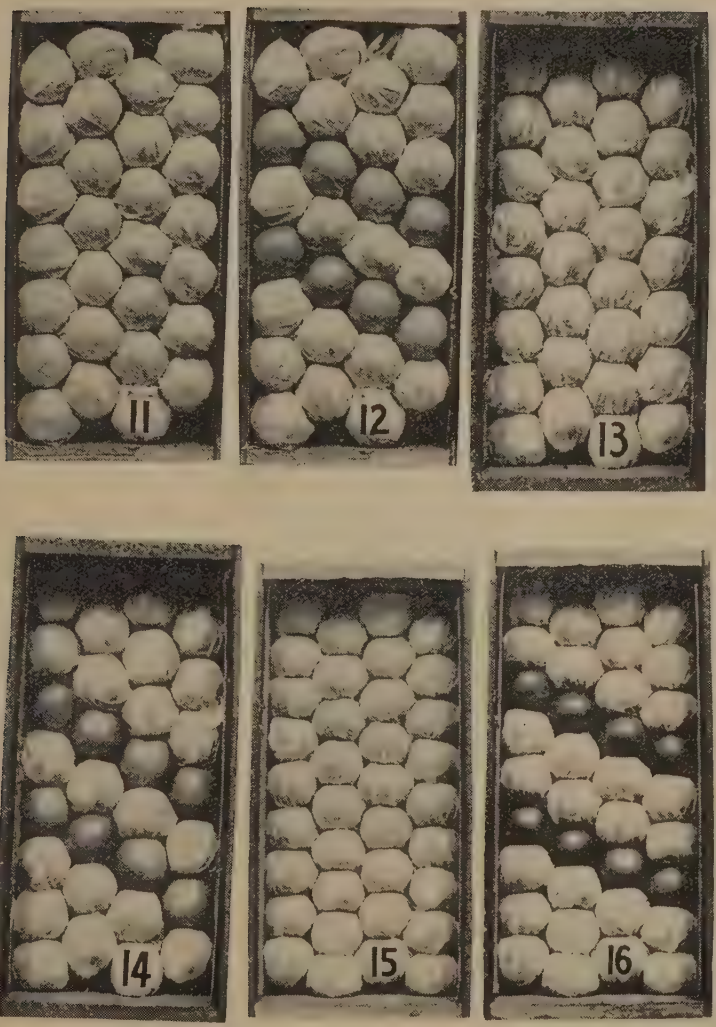
Practice will soon convince the packer that the flat apple will "top up" to a satisfactory height, with less trouble than a long type apple, where similar packs are used for both. Therefore, as before stated, it is essential, to achieve the best results, to know just what pack to use for each type and grade.

THE "PACK."

In proceeding with the actual arrangement of apples in the box, the packer should ralise that the fruit must be so arranged as to effect, when the lid is nailed down, a firm pack that will withstand the usual handling in transit, and when its destination has been reached, will open up reasonably free from pressure or other bruises, and appear before the buying public as an excellent product.

To achieve this objective is, undoubtedly, the aim of all growers and packers, but Nature provides such varied types of apples that it is sometimes difficult to accommodate all the types to a box of one shape and size, and the operation calls for a certain skill and experience.

It has been the task of our pioneers to evolve the original scheme of arranging the fruit and to place before packers, valuable information, arranged in order and readily understandable. Naturally, from time to time, slight modifications of the schedule were found advisable, and such alterations have been adopted where practice has proved their worth. Most, if not all, of Western Australian apple growers are familiar with the excellent "pack" known as the "cheek diagonal," which is a complete reversal of the old "calyx up" pack, the latter being now entirely superseded by the former.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We shall then consider the "cheek diagonal" and "cheek straight" packs as most suited to our use. "Cheek," as the word implies, means the placing of the apple on its cheek or side in the box, the terms "diagonal" or "straight" meaning the "direction" the apple takes in relation to the side or end of the case, "diagonal" showing the calyx looking diagonally towards the side, and "straight," the calyx pointing directly to the end.

There are degrees of firmness in packing, and, although the packer may at times be justifiably proud of showing to the layman how he can upend a full unlidded case without disarrangement of the fruit, there are certain packs which he knows would top up too high if packed with a similar firmness.

Two terms are suggested as being sufficient guide for our purpose, the "firm" and the "free" packs. The former is usually termed "tight" pack, but it may be noted that so-called "tight" packs do not always conform to firmness of every apple, some being removable without any trouble, not having been "firmed" to their fellows.

In the "firm" pack each apple should be placed in the box so as to occupy as little space as possible without crushing. The "free" is a pack that, although not "loose" is not one in which the case may be upended, before lidding, without disastrous results. A "loose" pack is to be condemned, as too much space is left between apples, and, unless very carefully packed, there is a tendency to "rattle" after handling in transit, also the widely spaced fruit does not show to advantage when the case is opened.

Some packing charts show opposite the necessary "counts" advices such as "pack more loosely than usual"; "pack tighter than usual," etc. In the absence of such a chart the following formula is given in order that a packer may, by a simple calculation, determine whether the "pack" has to be "firm" or "free," that is to say, he will know just how to dispose of the amount of apple he will have, in taking up the spaces between fruits and providing necessary top and bottom bulge.

The Formula.—Multiply the diameter in inches of the apple by the number of layers in the proposed pack, and subtract the depth of case in inches, for example—

Suppose the beginner takes up a 2½-inch apple of the medium type, and proposes to pack it in the orthodox 3-2 × 7 layer, and is not sure whether to pack "firm" or "free." Apply the formula—

Grade of apple, 2½ inches; number of layers, 7—17½ inches
Deduct depth of case—14¼ inches
Remains—3¼ inches

This, of course, means that if the grade is kept "up" there will be a difficulty in disposing of that much apple without having the pack uncomfortably high for lidding, and the obvious thing is to make this a "free" pack with the type and grade of apple mentioned.

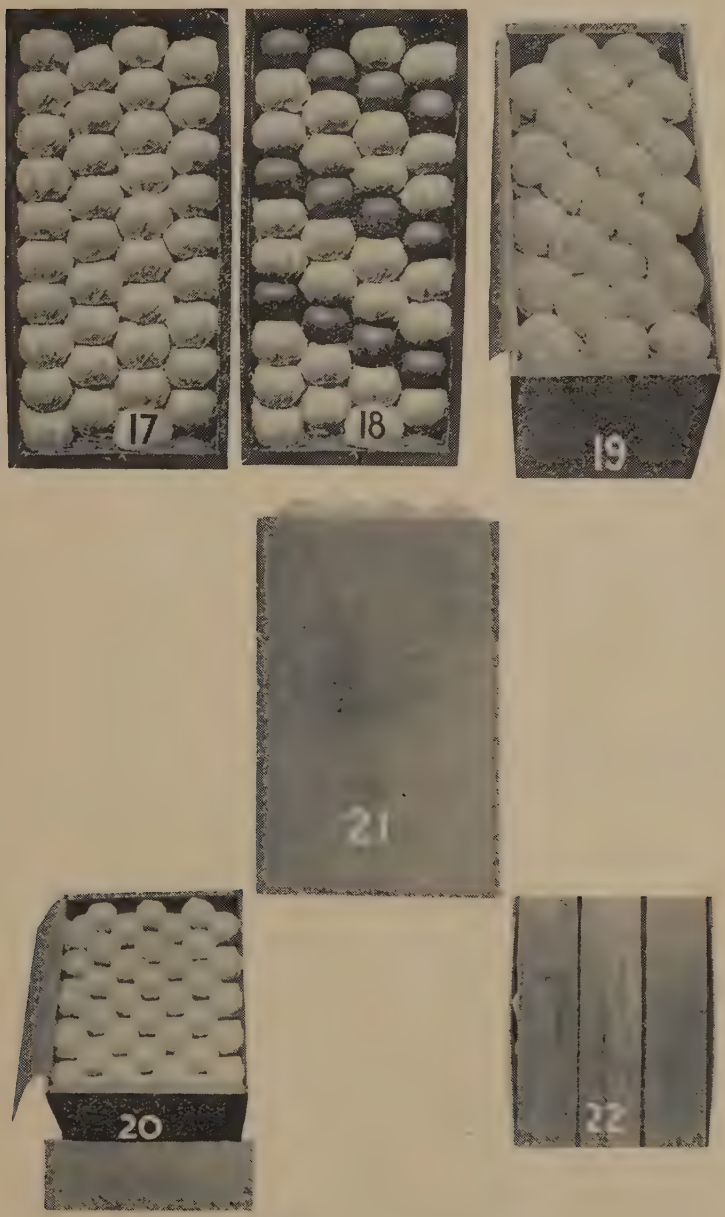
Take a further example, same type apple—

Grade of apple, 2¼ inches; number of layers, 7—15¾ inches
Deduct depth of case—14¼ inches
Remains 1½ inches.

In this case the packer has but 1½ inches of apple to provide a bulge and fill "pockets" or spaces between apples.

This would mean that a very firm pack must be used to bring the fruit up to a satisfactory height. It is well to remember that long type apples offer deeper "pockets" for each succeeding layer, and therefore, if there is very little apple to dispose, it is advisable to try out a different pack for certain grades.

The above is just a suggestion for the beginner as, after some practice, the packer will know just what to allow for such type of apple.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THE COUNT.

The beginner must now consider what "counts" to apply in packing the various grades and types. "Count" means the number of apples placed across the case, and the number runs each way to suit. Reference to illustrations 2, 3 and 4 will make this clear. Illustration 2 shows an apple in each corner representing the first row across. Now, an apple in the centre and touching the two corner apples, represents the second row across. This order is continued until the layer is completed. The "count" lengthwise is five rows 7 apples, second row 7 apples, the layer showing that order right across, thus the term 2-1 × 7-7.

Illustration 4 shows, in the first row across 2 and 2, and lengthwise 6 and 5. This is the 2-2 × 6-5 pack.

Illustration 3 shows 3 and 2 apples in the first and second rows across, with 5 and 4 apples in the first and second rows lengthwise, as the pack is 3-2 × 5-4.

All apples are packed to the outside lining layer in these rows as they, the only difference being in the "counts" lengthwise, which vary according to each grade.

THE 2-1 × 5 LAYER PACK.

This pack (illustration 5) is used for apples of 2¼-inch diameter, the method of placing the apple being "check" straight pack; and with the smaller sizes in this section, the pack must be very true. In the illustration the "count" lengthwise is 7-7, and it will be found that this number will decrease as the grade of the apple increases, as 6-6, 6-5, etc.

Illustration 5 shows the 2-1 × 7-7 packed case opened on the side to show number of layers and their arrangement.

THE 2-2 × 6 LAYER PACK.

This pack is most generally used as it suits the grades from 2½ inches to 3¼ inches. The number of layers in this pack is 4, and the "count" varies from 7-7 lengthwise to 5-4.

Illustrations 6 and 7 show the flat type apple (2½-inch "Emmas") 2-2 × 6-6 pack, 7 being the case opened on side.

THE 2-2 × 7 LAYER PACK.

Although many packers have definitely adopted this pack for certain varieties, caution should be observed not to overdo it, as, being an even "pack" the beginner may unconsciously drift into what may be a very undesirable general practice of using the pack with all varieties.

This pack should be used only in packing true long type apples of 2¼-inch and 2½-inch grades, and perhaps and the type apples of next 2½-inch grade. In the case of the long type ("Delaware") illustrations 8, 9, and 10 show the same case; 10 being opened on the side. In 9 some papers are removed to show the "direction" of the calyx. It will be noted that the apples on the extreme right have the calyxes or eyes pointing to the right-hand side of the box, but in all the other apples they have the left side direction. It is important to remember this point, as its observance will assist to get a more uniform diagonal as may easily be seen, and will avoid, by having eyes to calyx, breaking the skins through hard eyes subpressing into the apple cheek.

The same rule applies to the 2½-inch grade long type apple ("Delaware"), illustrations 11 and 12, showing the diagonal "check" pack. The uncovered apples in 12 will show the direction as in the 2½-inch "Delaware."

Dealing with the neat 2¾-inch apple, it will be found in practice that an apple 2 5 16-inch or 1 16-inch over 2¼-inch will pack 2-2 × 7 layer "cheek" straight pack, without slipping out of place, as the normal box is 8⅝ inches inside width, and the four apples across will measure 9¼ inches. It is, therefore, important to remember that the apples chosen for this pack must not be below the 2¼-inch grade. The packer will find, with this "pack" a check on grading of small apples, of which there are a great many in some seasons. Should the apple be under grade it will slip past the apples in the preceding row. The "count" lengthwise will vary according to the type of apple packed. Illustrations 13 and 14 show neat 2¼-inch apples, long type ("Cleopatras"), packed 2-2 × 8 7 × 7 layers, the unwrapped rows in 14 showing the direction of calyx.

Illustrations 15 and 16 show the medium type 2¼-inch grade packed 2-2 × 9-9 × 7 layers "cheek" straight pack.

Illustrations 17 and 18 show a neat 2¼-inch flat type apple packed 2-2 × 10-9 × 7 layers "cheek" straight pack.

THE 3-2 × 7 LAYER PACK.

This pack is recommended for all flat and medium type apples varying in grades from 2¼ inches to 2½ inches. In this section will be found a great number of apples sent regularly overseas, and the packer is here again advised not to put these grades into the 2-2 × 7 layer pack, as the 3-2 × 7 layer pack, if properly graded, is much better.

Illustrations 19 and 20 show a medium type ("Rome Beauty") packed 3-2 × 5-5 × 7 layers; 20, the case open on side.

All of the smaller grades require a firm pack. In all "cheek" diagonal packs, the outside layers, that is, the apples touching the sides of the box, must show the calyx pointing diagonally towards the sides. The inside rows may be "tilted" to suit the pockets made by the underneath layers, but must have a direction diagonal to the side of box.

THE 3-2 × 8 LAYER PACK.

This pack is to be used for apples of 2-inch and 2⅛-inch grades. Although most growers are anxious to avoid having to pack such small grades, at times owing to adverse weather conditions or very heavy crops, quantities of small apples are produced. The quality of the fruit is mostly good, and it stands up to handling for export excellently. These grades should be packed in the 3-2 × 8 layer style.

The packer will quickly realise that the 3-2 × 7 layer pack is unsuitable, as it will be found that 7 apples of 2½-inch grade, placed cheek to cheek, will give only 14⅞ inches, allowing approximately ⅜ inch for "pockets" and "bulge." Eight layers will give the packer 2⅜ inches, which will very nicely bring the fruit to the desired level.

Do not attempt to pack these grades in the 2-2 style.

The 2-inch apple, which means that the fruit cannot be put through a 2-inch diameter ring without undue pressure, must be packed "firm" to secure a satisfactory height.

THE BULGE.

In addition to the case being filled there is necessity for the apples to be above the top of the case before nailing down, so that the lid, which is flexible, will show a "bulge" of half an inch, at least, in the centre of both top and bottom.

Illustration 21 shows a 2-2 pack, medium type ("Dunns"), 2¾-inch grade, and the bulge shown in illustration 22 resulting from that pack. A more pronounced bulge is permissible in the "free" packs as the apples will settle slightly more after lidding.

THE PRINCIPAL INSECT PESTS OF TOBACCO.

L. J. Newman, F.E.S., Government Entomologist.

In recent years considerable attention has been given in this State to the growing of tobacco.

Many small and experimental plots, also larger commercial areas, have been planted with the view of testing out the possibilities of growing a commercial quality of tobacco, in payable quantities.

The tobacco plant is indigenous to tropical America. Throughout the tobacco growing regions of America this plant is subject to insect enemies. These insects are not numerous, but some of them are difficult to control.

The tobacco is a member of the same family of plants as the potato and tomato, and hence it is likely that the same insects which attack these crops will also turn their attention to the tobacco.

It is not intended here to suggest that in Western Australia we have any more serious tobacco pests to contend with than other tobacco growing countries. It must, however, be recognised by those intending to try the growing of this crop, that it is one that demands close husbandry. It will prove a serious mistake to spread one's energy and labour over too great an area. A few acres well tended will yield better and payable results than larger areas more or less neglected. It is not the quantity of the leaf grown that counts first, but the quality. The aim is to produce a leaf of the required texture, colour, flavour, and burning quality.

Insects are a considerable factor to be considered in the production of good quality leaf.

Damage to the crown bud or by insects boring into the stem may prevent the continued growth of the original stem so essential to the production of first quality leaf. This damage causes the production of lateral growths which do not yield as large or as fine a leaf. Anyone walking through a tobacco field cannot fail to observe the numbers of holes eaten in the leaves by caterpillars, grasshoppers, etc. These holes in a leaf may not affect its use, but certainly reduce the yield and value.

The number of insects injuring the tobacco leaf is large compared to those which injure other parts of the tobacco plant.

A great deal of this injury can be prevented if proper methods of treatment are employed. As before stated, it is not a crop that can be grown for profit unless carefully attended to.

Tobacco is one of those annual crops grown in seedling beds and transplanted to the open field. This is a stage when the plants should be kept under keen observation as they are then very susceptible to damage by cut-worms. The fact that the land to be planted may have been under a crop of clover grass or other weeds, renders it very likely that cut-worms are already in the soil when the planting out is done.

The ideal condition for the control of many of these insects is to place the land to be used for the tobacco crop each year under clean fallow for some time preceding the planting, thus starving out the insects.

It is particularly important that all weeds and rubbish should be destroyed, as these act as harbouring and breeding places for some of the worst insect enemies of tobacco. The grower who permits these weeds to grow in or near his tobacco crop is inviting trouble. The fact that the tobacco is related to other commercially grown crops such as tomatoes, potatoes, cape gooseberries, and other solanaceous plants, is an important factor to keep in mind.

It naturally follows that it would be unwise to attempt to grow a crop of tobacco following on a crop of any of the above-mentioned plants. Rotation of crops is, therefore, positively advised. Failure to practice a system of crop rotation is not only ruinous to soil fertility, but is bad from an entomological standpoint. Therefore, if a field is planted to tobacco this year that was in tobacco last year, it falls heir to a crop of insects which developed in the tobacco the year before. On the other hand, it follows that if a tobacco crop is followed by a very dissimilar crop, many insects dependent upon solanaceous plants for their continuance will be starved out. No one rotation will avoid all insects, some of which are general feeders, but it will go a long way towards control of some of the worst pests.

A further very important point in the preventive measures is to see that all old, useless, and especially overwintering plants are pulled up and destroyed. If allowed to continue suckering, they will act as breeding grounds and thus carry on the pests to the following growing season.

Combative measures.

To control the various leaf eating and sap sucking insects which attack tobacco, spraying, dusting or poison baiting must become a regular farm practice with tobacco growers.

Against chewing or biting insects it is somewhat of an open question whether the insecticides can be most effectively applied as a wet or dry spray. The dry method is quicker and, I believe, as effective.

Spray mixtures are divided into two classes. First, those that kill by coming in direct contact with the insect and which corrode and eat away its body walls, stuff up its breathing spiracles or poison, by being forced into the body per medium of the spiracles. These are known as "contact insecticides." Such mixtures cannot be applied in advance of the insects, but must be applied directly on to the insects themselves as a wet spray.

The second class of insecticides are known as "stomach poisons." They are used against insects that chew their food and they kill because they are real poisons and are taken internally with the food. These can be applied in advance of attack and in either a wet or dry form.

There is also the method of combining a fungicide and insecticide.

If it is found necessary to use a Bordeaux spray in the seed bed or elsewhere, and leaf-eating insects are also present, arsenate of lead may be added. To every 50 gallons of the Bordeaux add 1½ lbs. paste arsenate of lead or ¾ lb. powder form. This spray must be used as soon as the poison is added and kept well agitated.

To apply the wet spray, the farmer will need some sort of spray pump; for the dusting a bellows or dust gun must be provided.

In the use of contact sprays, it is very essential to possess a pump having a pressure of at least 60-80 lbs. to the square inch. Many failures follow the use of contact sprays because of the lack of power in the spraying apparatus.

In spraying sap-sucking bugs, it is of little avail to simply wet the insect. The spray must be forced into the breathing spiracles, which can only be accomplished with a suitable pump. It is no good using a weak atomiser which simply forms a dew-like moisture over the insect. The bugs must be thoroughly and forcefully immersed in the spray.

In the use of poison sprays on tobacco, it is advisable not to apply same to plants, after having reached the growing stage of topping; non-poisonous contact sprays should suffice from then onward.

As a matter of fact, it has been determined by the Bureau of Chemistry, America, that there is very little danger of poisoning from tobacco sprayed with

arsenate of lead. The use of the wet spray, however, after the period of topping has been reached, tends to leave a whitish discolouration on the foliage which may be regarded by buyers as detrimental.

In deciding what action to take in dealing with an insect, farmers should be able to recognise the structure of the mouth parts.

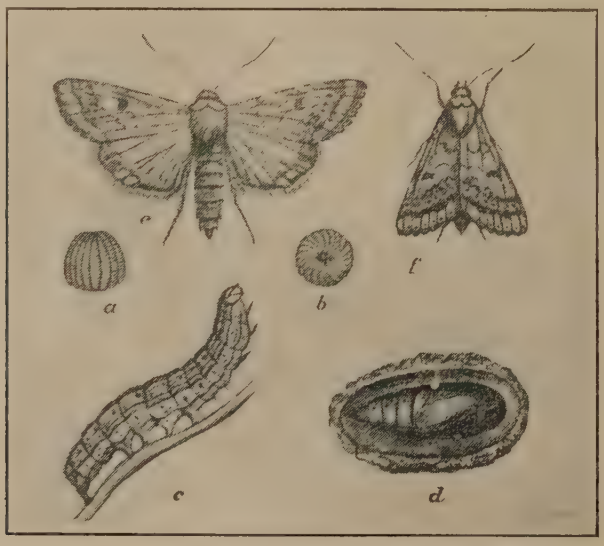
Fundamentally, insects are divided into two classes, biting or chewing and sucking. If the leaves are being eaten or the stems bored, then it should be recognised that a poison spray or dust to the foliage is required.

If, on the other hand, the pest is determined as a sap-sucking one, then a contact spray is required. It is of the first importance for farmers to be able to determine which class of insect he is trying to combat, in order that he may select the proper spray mixture to use against it. This observational knowledge will save much loss of time, material and labour so often expended in the application of the wrong spray.

THE CLIMBING CUT-WORM OR TOBACCO BUD-WORM (*CHLORODEA OBSOLETA*).

Order—*Lepidoptera.* Family—*Noctuidae.*

This insect is of no new occurrence here, having been reported as a pest for the past 30 years. It is an introduced insect and attacks many kinds of plants, both cultivated and wild. This very general dietary and its rapid reproductive powers render its subjugation or control extremely difficult.



Life stages of the Climbing Cut-worm *Chlorodea obsoleta*).
U.S. Dept. Agr.

Description.—It is a stout-bodied moth measuring about ¾ inch in body length with a wing spread of 1½ inches. The front pair of wings are usually of a drab brownish colour with brown markings. The hind pair are creamy white with the hind edges shading to black. There are considerable variations in the colours of this moth as there are in the caterpillars, but the above description applies to it generally.

It is a noctuid or night-flying moth, hiding away during the day unless disturbed.

Each female moth is capable of depositing many hundreds of eggs. These are usually placed singly on the plant. The eggs are tiny white objects flattened at both ends and corrugated. They hatch, according to the weather, in from 3-6 days. *The larvae or caterpillars when first hatched* are pale whitish creatures which commence at once to feed upon the foliage or buds. As they grow and moult, they appear in various colours and markings. The caterpillars are full grown in from 18-20 days.

These larvae differ in habits from many other noctuid caterpillars, in that they do not confine their feeding to the foliage but show a decided preference for the buds, flowers and seeds.

Pupae.—These are generally found in the soil at a depth of 2 to 3 inches, encased in a flimsy cell, lined with silk. The pupation period is 14 to 16 days (summer) when the moth issues to carry on the work of destruction. The main swarm of caterpillars of this moth appear in September, October, and November, lesser broods appearing at intervals throughout the summer and autumn.

Measures of Control.—Keep down all weeds and rubbish. Plant crop, if possible, on clean fallow.

The importance and effect of clean and careful methods of farming are, I fear, usually under-estimated, it indeed they are realised at all. If land has been allowed to become full of weeds and rubbish prior to turning in and planting to tobacco, many eggs, larvae and pupae of this moth will be present in the soil.

Avoid dirty headlands, as it is useless destroying the insect in the crop if we, by other neglect, offer them breeding grounds alongside. Such areas should, if caterpillars are present, be also treated with spray, dust, or bait.

Arsenical sprays or dusts should be relied upon for the control of these caterpillers on the foliage. If attacking the buds, a poisoned bait is applied. The chances are that if the plants are kept well sprayed or dusted at intervals of 10 to 12 days up to the time of topping, the young caterpillars will be destroyed before they can do much damage.

The strength of spray to use is as follows:—Paste arsenate of lead, 1½ to 2 lbs. to 50 gallons of water.

The use of poison dust sprays is quicker and certainly more popular. This is due to the fact that the use of a wet spray entails the cartage of water which is heavy, and the supply may be somewhat distant from the scene of operations.

The dust should be applied with a suitable bellows or dust gun, if good results are to follow. Whichever method is adopted, the work must be thoroughly done, seeing that all parts of the plant are coated with the poison.

The general dusting formula is 25 lbs. powdered arsenate of lead to 75 lbs. slaked lime, or other inert diluent, every 10 days.

If the caterpillars are numerous and more advanced, use equal parts of the powdered arsenate of lead and lime.

The dust should be applied in the early morning whilst the plants are moist, and there is little wind.

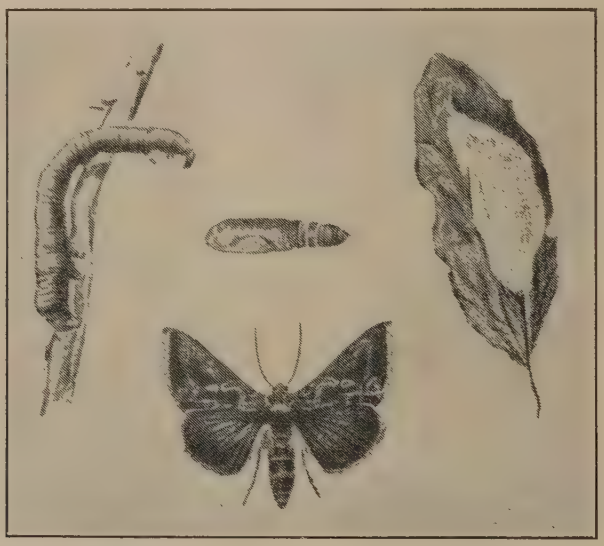
The use of Paris green as a dust is not advised, as there is always a danger of foliage burn when this is used. With practice one can soon become expert at spraying or dusting.

In general, do not use the poison sprays after the topping stage of the tobacco plant has been reached.

If the caterpillars are attacking the buds or growing points, the following bait is advised: —1 lb. powdered arsenate of lead to 25 lbs. pollard. Mix thoroughly together, and apply to the tip of the growing plant. It is necessary to emphasise the need of placing the bait into the centre of the bud. The early applications may be made by means of a finely-perforated tin fastened to a stick. This is shaken over the bud. As the plant increases in size, the bud leaves become more tightly folded, and it is then necessary, to get maximum results from the baiting, to apply the remedy by hand. The bud leaves are carefully parted and the bait dropped in. Care should be taken to see that only a small pinch of the poison mixture is applied to each bud, as excessive quantities may cause bud burn. This baiting should be done at intervals of 7 to 14 days, according to the necessity.

If late foliage treatment after topping is required, it would be wise to use a non-poisonous contact spray such as clensel, katakilla, or pysect. Clensel, 1 part to 25 parts water; katakilla, 1 carton to $2\frac{1}{2}$ gallons water; pysect, 1 part to 100 parts water.

For leaf eating caterpillars, such as the Green Potato Looper (*Plusia argentifera*) and other cut-worms, the treatments as advised for the Climbing Cut-worm will prove effective.



Life stages of the Green Looper caterpilla (*Plusia Argentifera*).
U.S. Dept. Agr.

THE COMMON CUT-WORM (*AGROTIS MUNDA*).

Order—*Lepidoptera*. Family—*Noctuidae*.

The moth is a typical noctuid or night-flying form. Colour—Forewings pale brown, mottled with darker brown and grey. The hind pair very light fawn, with darker shadings towards the outer edges and bordered with a fringe of fine light hairs.

The eggs are small, white objects laid sometimes singly or in clusters on to foliage or on the soil at base of plant attacked. They hatch in 6 to 8 days.

Larva or caterpillar.—Thick, fleshy, and tough. Colour, ranging from sandy brown to murky green, and sometimes showing faint lines along the back and sides. Body almost hairless. When touched, these caterpillars curl up and feign death.

Pupa.—Pale brown, with small spine at posterior end. Generally found at base of plant, usually, but not always, enclosed in small cocoon covered with particles of soil. There are several generations in a year, the most damaging being October, November, and December.

Common Cut Worm (*Agrotis munda*), depicting larvae, pupa, and adult.

The caterpillars come from the ground at night and feed upon the foliage, or cut the young plants off at the ground level. Upon the advant of daylight, they leave the plants and return to the soil at the base, and there remain concealed all day.

If the ground to be planted is suspected of harbouring these cut-worms, it should be thoroughly baited before plants are set out. This treatment to be repeated after planting and whenever cut-worms are found in the crop. Ground baiting should only be applied to the species of cut-worms which return to the soil after feeding.

Poison Bait.—Bran 40 lbs., Paris green or arsenate of soda 1 lb, molasses or treacle 3 lbs., water to make to a crumbling mash. In preparing this bait, mix the bran and poison powder together dry. Dissolve the molasses or treacle in sufficient water to make liquid, and wet the bran and poison until of the consistency of a crumbling mash.

Scatter this bait along the rows or around the plant to be protected, seeing that it is not placed immediately against the stem. To be most effective the bait should be spread as late in the evening as possible, so that it will be moist and tempting when the caterpillars come out at night.

Sodium fluoride used at the rate of 1 lb. to 30 lbs. of bran is an effective bait.

In Queensland the following bait is advised:—Bran 12 lbs., pollard 12 lbs., Paris green 1 lb., molasses 1 quart, water 2 gallons. This is somewhat stronger than generally recommended, and might be applied in the case of gross infestation by cut-worms. The quantity of bait used per acre ranges from 10 to 20 lbs.

If caterpillars are invading a crop from outside sources, they can be successfully prevented from so doing by the ploughing of a sharp well cut trench. The furrow should be ploughed or cut with the sharp edge opposed to the caterpillars advancing on the crop. They fall into the trench, and are unable to climb the steep opposing side. They travel along the bottom of the furrow, and if poison bait is placed therein, partake of same to their undoing.

THE POTATO MOTH OR TOBACCO LEAF MINER AND STEM BORER (*PHTHORIMAEA OPERCULELLA*).

Order—*Lepidoptera.* Family—*Gelechiidae.*

This, if not the most destructive of the moth pests, is certainly one of the most difficult to control.

Life cycle. The eggs.—The eggs are tiny white, oval bodies with a pearl-like lustre, about half the size of a small pin's head. They are laid in batches upon the foliage or stems of the plants and hatch in from 4 to 6 days (October to May).

Arrow indicates eggs on leaf.
(Original.)

Larva or caterpillar.—The young caterpillar on hatching is about $\frac{1}{16}$ inch long, light yellowish, almost transparent body and black head. When full grown is from $\frac{1}{2}$ inch to $\frac{5}{8}$ inch long, varying from dirty white to dull green and sometimes to a decided pinkish or flesh colour. The duration of this stage is 17 to 22 days (summer). The young caterpillar on hatching, at once seeks a suitable point of entrance into a leaf or stem. In the case of the leaf, it cuts its way into and

between the epidermal layers or skins. There it feeds, eating out the green or chlorophyll matter. If the stem is attacked, the larva seems to prefer entrance at a node or base of a leaf or side shoot.

The pupa.—About three-eighths of an inch long, colour varying from light to dark brown, enveloped in a dirty white silken cocoon, covered with bits of dirt, excrement, or other refuse.

Pupation period 11 to 14 days (summer).

Moth, measures little more than ½ inch from wing tip to wing tip.

The anterior or front pair of wings are grey and slightly speckled with darker markings, and in certain lights exhibit a distinct metallic sheen. The posterior or hind pair are of a uniform light grey and fringed wth remarkably fine hairs.

Potato Moth or Tobacco Leaf Miner and Stem Borer (*Phthorimaea operculella*) (*original*).

The moths are night flying, and live for 11 to 20 days (summer), and lay from 80 to 120 eggs each. There are at least four generations of this insect during the summer months.

The conditions which favour this moth are dry warm weather, the pest reaching its maximum in late autumn.

Character of injury.—The larvae mine the leaves and bore into the stems. The presence of the caterpillars in the leaves is revealed by the parchment-like patches due to the caterpillar having eaten out all the green matter.

If the stem is attacked a swelling is often produced, further, the plant wilts from above the point where the larva is working.

Upon cutting open the stem, the small caterpillar is found to have hollowed it out and rendered the plant liable to snap off at the point of injury.

Preventive measures.—First and foremost, see that the land to be planted to tobacco has not grown a previous crop of potatoes, tomatoes, or other solanaceous plants. Keep as far away as possible from any such crop. Destroy all old potato

Typical injury caused to leaves by the larvae of the Potato Moth. Note parchment-like patches.

(Original.)

and tomato tops, and cull tubers. Never store potatoes in the vicinity of a tobacco crop. Land to be planted to tobacco must be well worked and freed of all growth, for as long a period as possible before planting.

The plants found to carry and harbour this pest locally are the following:—Potato, tomato, Cape gooseberry, egg plant, nightshade, and apple of sodom.

Treatment.—The study of this insect has revealed a weakness that can be taken advantage of. The caterpillar does not pass the whole of its life in the one leaf or tunnel, but has a habit of wandering at different stages of its growth from one part of the plant to another, re-entering at any point it may determine. A knowledge of this migatory habit is valuable, and should be made use of. To this end it is advised to use the wet or dry sprays as applied to the Climbing Cut-worm. If the plants are kept coated with the poison the young caterpillars in eating about here and there before entering or re-entering a leaf or stem, consume sufficient of the poison to cause their death. Once they have gained entrance to the leaf or stem they are safe from all treatments until such time as they decide to come out and seek a fresh entrance.

If plants are observed to be wilting, an examination of same will reveal whether the wilt is due to the presence of the potato moth larva in the stem, or other cause.

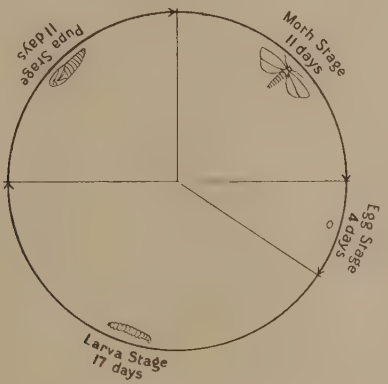


Diagram illustrating life cycle of Potato Moth.

(Original.)

If due to this pest, cut back plant to a sound bud, below the point of attack, and destroy the removed infested portion by burning. This cutting back will cause delay in maturing the leaf, and will induce considerable suckering. Remove all suckers, other than the bud to which the plant has been cut back. This appears to be the only hope once the wilt stage has been reached.

In moving about amongst the plants, any transparent patches observed should be pressed between the fingers, thus destroying the caterpillar within. All old or useless plants to be destroyed, and the land left clean.

Knowing, as we do, that this pest becomes progressively worse, as the dry summer continues, it is a good plan to plant the tobacco crop as early as possible in the spring, thus bringing it to maturity before this leaf miner has become numerous.

GREEN TOMATO AND BEAN BUG *NEZARA VIRIDULA* (LINN.).

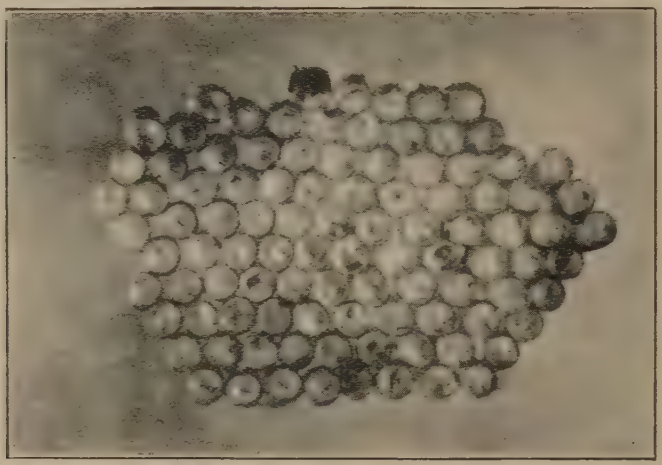
Order—*Hemiptera*. Family—*Pentatomidae*.

This bug first came into prominence in this State in the year 1920. It was described by Linnaeus in Europe, as far back as the year 1758. It is recorded from Europe, Asia, Africa, North America, India, and Australia.

Since 1920, as predicted, it has spread to many parts of the State and has now become one of our major summer insect pests. It has a large number of host plants and fruits upon which it feeds, showing a strong preference for tomatoes and French beans, hence the name we have given to it.

Life history.—There are three stages in the life history of this bug, namely, the egg, nymph and imago or adult.

The eggs are white and are deposited in clusters of various numbers up to 100, side by side, usually upon foliage.



Typical egg mass of Bug. Enlarged (original).

The average period of incubation or hatching of the eggs is 8-10 days, according to temperature.

The young emerging bugs push off the cap of the eggs and appear as a dense cluster for several hours. After the first moult they scatter about over the plant.

The nymph or young bug on emergence is dark reddish coloured with a distinct bluish spot on the centre of the thorax. After the second moult, it appears almost black with varying brownish spots on the outer margin of the thorax and the abdomen covered with rows of white spots. Varying patterns are exhibited after each of the moults. After the fourth moult, the bug comes forth with definite wing pads, antennae 4 jointed, green, shading to brown at tip; thorax pale green with scattered black spots, abdomen in the main pale green with central portion red, surrounded with white markings, the lateral margin of the abdomen and outer margin of thorax pale red. After the fifth and final instar or moult, the full adult winged insect appears as a foliage green-coloured bug. These stages take from 6-9 weeks.

The adult winged imago is oblong oval in form, about ⅛ inch long. Dark green above, paler green below. There is a total dissimilarity in colour and markings between the pre-winged and winged stages of this bug. This great variation

Second nymphal stage after leaving egg. Enlarged. (Frogg.)

Fourth or final stage. Note wing pads forming. Enlarged 3 times. (Original.)

has led to much confusion amongst growers. In fact, many have mistaken the immature bugs for ladybirds. The adult bug lives for several months. There are a number of overlapping generations between October and April. The winter is passed as hibernating adults and nymphs.

Adult or Imago stage. Enlarged 3 times. (Original.)

Nature of injury.—This bug is termed a Haustellate insect, or, in common parlance, a sap sucker. The rostrum or beak is inserted into the sap cells and their contents sucked out. The doing of this not only injures the leaf tissue, rendering it dry and discoloured, but the effect of these myriads of sucking insects upon a plant during hot dry weather causes same to wilt and flag. It is difficult under our dry summer conditions to maintain a broad-leaved plant like the tobacco against the natural loss of moisture, due to transpiration. If, therefore, this natural loss of moisture through the leaves is greatly intensified by the sucking of these insects, it naturally follows that the plant will flag and dry up.

This pest has been observed in the seed beds, but as a general tobacco pest it has yet to prove itself.

Being so partial, as we have proved it to be, to potatoes and tomatoes, it is more than likely that it will turn its attention to the tobacco plant.

Treatment.—Knowing that the eggs of this bug are laid in clusters on the foliage of the plant attacked, much good can be accomplished by picking off these egg masses and destroying them.

The habit of the young bugs when first emerged and up to the first moult, is to live and feed gregariously so that they will always be found in clusters near the eggs from which they have hatched. They are more readily destroyed whilst in the pre-winged stage; therefore, every effort should be made to destroy them whilst they are sensitive to contact sprays. Once the adult winged stage is reached, it is a most difficult pest to destroy.

The bug is purely a sap sucker. It is, therefore, useless to apply poison dusts and sprays as for caterpillars. The only way a plant bug can be destroyed is by fumigation or contact spray. In general, fumigation is out of the question, owing to the cost of materials.

In the use of contact sprays, it is very important to see that the pump used has sufficient power behind it to ensure that the spray is forced into the breathing spiracles. As previously mentioned, the mere wetting of the bugs with the spraying material is not sufficient.

To meet the difficulty occasioned by the presence of this pest, the grower must provide a suitable spraying outfit. Whatever style of pump is used, it should be fitted with 3 or 4 feet of extension pipe, a curved elbow, and a good nozzle.

The following sprays can be used with good effect:—

Phenyle 1 quart, washing soda 3 lbs., soap 2 lbs., water 40 gallons. Shred the soap and dissolve by boiling in 2 gallons water, add the other ingredients, and break down to the required strength by the addition of the balance of water.

Another useful formula is the following: Soft soap 4 lbs., turpentine $1\frac{1}{2}$ pints, water 20 gallons. Dissolve the soap in 4 gallons of boiling water, remove from fire and allow to cool off, but not get cold. Add the turps, stirring thoroughly and make up to 20 gallons with water.

Carbolic Lifebuoy Soap spray.—1 cake of this soap to the gallon of water. Shred the soap, and dissolve by boiling. Apply warm.

Concentrated clensel, a proprietary spray, used at a strength of 1 part to 60 parts water is effective, especially against the pre-winged stages.

Pysect, a ready to use pyrethrum spray, at 1 part to 100 parts water is also good.

Katakilla proprietary spray, at a strength of 1 carton or packet to $2\frac{1}{2}$ gallons of water, will destroy the bugs.

All these sprays are non-poisonous. Never apply to foliage during very hot weather, or when rain is about to fall.

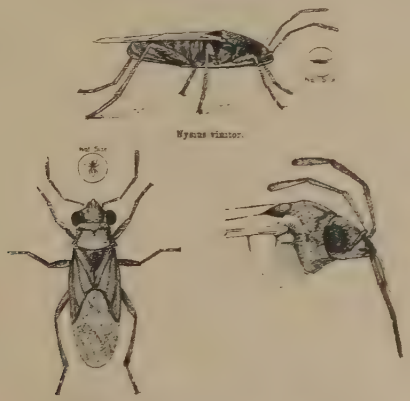
Do not use the phenyle or carbolic sprays just before picking, as they may impart an objectionable odour and flavour.

RUTHERGLEN BUG (*NYSIUS VINITOR*).

Order—*Hemiptera*. Family—*Lygaeidae*.

This bug, like the Green Tomato Bug, is a sap-sucking insect. The adult is small, and of a light greyish brown colour, about 1/6 inch in body length, and slightly under 1/4 inch from wing tip to wing tip. The wings are silvery grey, semi-transparent, and traversed by a few dark lines.

The eggs are elongate, slightly curved, white, and laid in clusters upon certain weeds or cultivated plants. They hatch in from 6 to 10 days. The nymphal or pre-winged stages of which there five, occupy about 24 days. The bugs are then full grown, having taken 34 days from egg to adult.



Rutherglen Bug (*Nysius vinitor*).
N.S.W. "Journal of Agriculture."

During the pre-winged stages the bugs are somewhat scattered. When adult they mass together. The females cannot lay until 10 days after reaching the adult stage. From 300 to 400 eggs may be laid. The damage is caused by the concentrated hordes which attack a crop.

Preventive measures.—Complete farm sanitation must be practised, which means the keeping down of all weeds and rubbish. All headlands and fence alignments, so often used as rubbish dumps, must be kept free of all rank growth and rubbish.

Treatment.—Keep a sharp lookout for the first signs of the pest, and when found take immediate action.

Generally speaking, the same sprays as advised against the Green Tomato Bug will suffice.

Black Leaf 40, 1 pint, soap 3 lbs., water 70 gallons is effective.

A proprietary spray, known as Benzole Emulsion, used at the rate of 1 lb. to 5 gallons water, gives good results.

A home-made preparation: Sunlight soap 8 ozs., turpentine 8 tablespoonfuls, water 4 gallons. Shred the soap and dissolve by boiling in 2 gallons of water. Remove from fire and allow to cool off, but not thicken, and stir in the turpentine. Make up to four gallons by the addition of a further 2 gallons of hot water. Apply hot.

Another good home-made spray is tobacco stems or dust 2 lbs., soap ½ lb. Place the tobacco and soap in 1 gallon of water and boil lightly for 1 hour, strain off, and make up to 6 gallons with cold water.

Dusting with Cyanogas Dust A 1 part, sulphur 2 parts, gives excellent results. This is, however, somewhat expensive.

Apply with dust gun as soon as foliage is dry, and when little or no wind is blowing. Keep to windward when using and inhale as little as possible, as it is a deadly poison. After giving off the hydrocyanic gas, the residual dust left on the foliage is quite harmless. Like all other dusts, it must be thoroughly applied. Do not apply to moist foliage.

Trapping method.—Make shelters or congregating places for the bugs by piling heaps of rubbish here and there between the rows of plants. The bugs will congregate under these heaps, and may there be destroyed by spraying or the application of boiling water. These bugs must be dealt with in the heaps before the sun has warmed them up.

Tarred screens or canvas, spread under the plants and the plants shaken, will cause the bugs to fall on to the screen where they will be held captive.

If outside areas are infested, a burning over will destroy myriads of the bugs.

Smudge or smoke fires are sometimes used against this bug as a means of driving a winged swarm out of a crop.

THE VEGETABLE WEEVIL (*LISTRODERES PRAEMORSA*).

Order—*Coleoptera.* Family—*Curculionidae.*

This pest has been found both in the seed beds and amongst the field crops. Up to date it has not proved to be a serious trouble. Knowing how widespread it is and what numerous host plants it has, including potatoes and tomatoes, it possesses dangerous possibilities as a tobacco pest.

This destructive beetle belongs to a small group of weevils which damage plants feeding upon same in both its larval and adult stages. It is nocturnal, or night feeding.

The grubs are legless and live in the soil, coming to the surface to feed at night. This stage occupies from 12 to 14 weeks.

When full grown the grub burrows into the soil from 1½ to 2 inches, forms an earthern cell, and therein pupates. This period under cage incubation lasted 17 to 21 days.

The imago, or adult—this is a typical weevil with short stout beak, bearing the usual elbowed antennae, clubbed at the tip. The general colour is light brown with the sides of the wing covers light fawn. The weevil has a corrugated appearance when looked at with a lens. Two oblique patches, consisting of light grey scales, forming somewhat of an inconspicuous V-shaped mark, are to be seen at the posterior ends of the elytra. Just below these marks are a pair of processes giving a pointed or spined appearance. The legs and undersides of the body are dark red. When handled it feigns death. Flight wings are present under the elytre, but so far we have not witnessed any flight.

Nature of damage.—The grubs feed upon the undersides of the leaves, the adults feed generally upon the foliage which they cut into holes. They are mandibulate or biting insects.

Prevention.—Keep land free of clovers, cape weed, and other weeds which readily harbour this weevil. Fallow is a certain method of ridding the land of this pest.

Treatment.—Poison bait. The same as is used for cut-worms. This bait is distributed around the plants to be protected, as late in the day as possible.

Spraying or dusting with arsenate of lead was also found to be effective. Paste arsenate of lead 1 lb., water 16 gallons, or powder arsenate of lead ½ lb.

Vegetable Weevil.
Listroderes obliqua (Gyll).
Dorsal or Back View.
(× 6 original.)

If using dust poison, apply equal parts powdered arsenate of lead and slaked lime.

Should this weevil appear in the seed beds, do not apply the Paris green bait. Spray with paste arsenate of lead, using 1 lb. to 16 gallons water, or dust with the following:—Pollard 25 lbs., powdered arsenate of lead 1 lb.

LOCUSTS OR GRASS-HOPPERS.

The common locut or grass-hopper is the species known as *Chortoicetes terminifera.* Order—*Orthoptera.* Family—*Acridiidae.*

These insects breed in the surrounding undisturbed lands. The eggs are laid in the soil. These hatch out in August-September. The prewinged stage covers a period of 6-8 weeks. Owing to irregular laying, the issue of hoppers occurs in what might be termed relays.

The adult or winged form.—The colour of the fore or front wings is light brown, mottled and splashed with darker brown and clouded at the tips. Hind wings transparent and clouded at the apex.

The general colour of the insect is amber brown, legs marked with spots or bands of chocolate brown. The body length from head to tip of folded wings about 1¼ inches. They are provided with strong wings and are capable of considerable flight.

Adult Plague Locust (*Chortoicetes terminifera*).

(Original.)

Control.—This offers many difficulties. The chief of these are the breeding grounds, roadsides, waste unoccupied, poor bare lands, etc. Here the eggs are deposited and hatch out unmolested, later migrating as the natural herbage dries up, into the surrounding crops. Every effort should be made to cope with the pest whilst in the hopper stage.

Burning over useless infested areas will destroy great numbers of the hoppers.

As non-poisonous sprays for the destruction of hoppers, the following sprays were found effective:—Burford's household Carbolic soap 2½ ozs. to the gallon of water and Sunlight soap 2 ozs. to the gallon. Apply hot. Most effective in the early morning when the hoppers are sluggish. Katakilla 1 carton to 2 gallons water may be used as a contact spray.

Spraying with arsenate of soda 1 lb., molasses 4 lbs., water 12 gallons, was very fatal to the prewinged stages. This spray can only be applied to the weeds and grass or directly on to the bodies of the hoppers. It must on no account be brought into contact with the growing crop, at is will burn the foliage.

Poison baiting.—Arsenate of soda or Paris green 1 lb., bran 30 lbs., molasses or treacle 4 lbs. Mix to a crumbling mash and distribute amongst the grasshoppers in the early morning. Having fasted all night, they readily take the bait which kills them. All baiting or spraying for the grasshoppers should be done in the early morning.

Typical ring of males as seen around egg-laying female.
(Original.)

If preferred, sodium fluoride may be substituted as the poison medium in the bait, using 1 lb. to the 30 lbs. of bran.

THE RED-LEGGED EARTH MITE (*HALOTYDEUS DESTRUCTOR*).

Order—*Acarina.*

Mites are not true insects, but as some species cause damage to plants and animals, they are included in Agricultural Entomology.

The above mite now constitutes one of our most serious winter plant pests. Its damage to tobacco is confined, in the main, to the young seedling stage and for a period after planting out. Once the plant begins to make rapid growth and get away from the soil surface, the mite does not cause serious trouble.

Life history.—The mite makes its appearance about the first week in May, following the advent of the winter rains. These young mites have hatched from aestivating or over-summering eggs. These eggs were laid in the late spring as the pastures dried up. They resist the dryness and heat of the summer, hatching out in the autumn.

The eggs are oval smooth bodies, reddish orange colour, attached to objects, under clods of earth, or as in the winter laid on to the foliage of the plant. The winter eggs hatch in from 8-10 days.

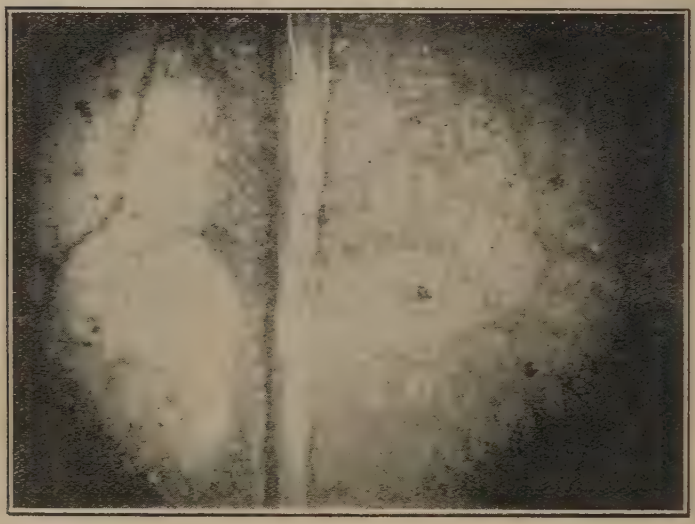


Fig. 1. (Original.)
Eggs of mite on leaf surface, greatly magnified.

The larval stage.—The newly hatched mites are six-legged. Within seven days they go through a moult, casting their skin and appearing with eight legs.

The nymphal stage.—During this period several moults take place, until the adult stage is reached. This period occupies 25-30 days.

Imago or adult.—Size 1/25th inch. Colour—mouth parts and legs bright red, body dense velvety blue-black. The mite is soft bodied and very delicate. The mouth parts are formed for rasping rather than for piercing. The life of the adult is 30-35 days.

Fig. 2. (Original.)
Adult female, dorsal view, magnified by 20.

Fig. 4. (Original.)
Adult male, magnified by 20.

Fig. 5. (Original.)
Adult female, ventral view, showing eggs in body, magnified by 20.

Fig. 3. (Original.)
Adult female, ventral view, magnified by 20.

This pest attacks many kinds of plants, showing a preference for clovers and other legumes. Cape weed is also a common host plant. Potatoes are seriously attacked and tobacco in the young growing stages.

Treatment.—Keep down all weeds and rubbish. Place land to be used as seed beds under clean fallow. Plough land to be planted deeply. Dip all seedling plants in a solution of black leaf 40 and soap before planting out. 1 teaspoonful black leaf 40, 1 oz. soap, 1 gallon water.

For a general spray for seed beds and young plants, black leaf 40 1 lb., soap 3 lbs., water 70 gallons, is effective.

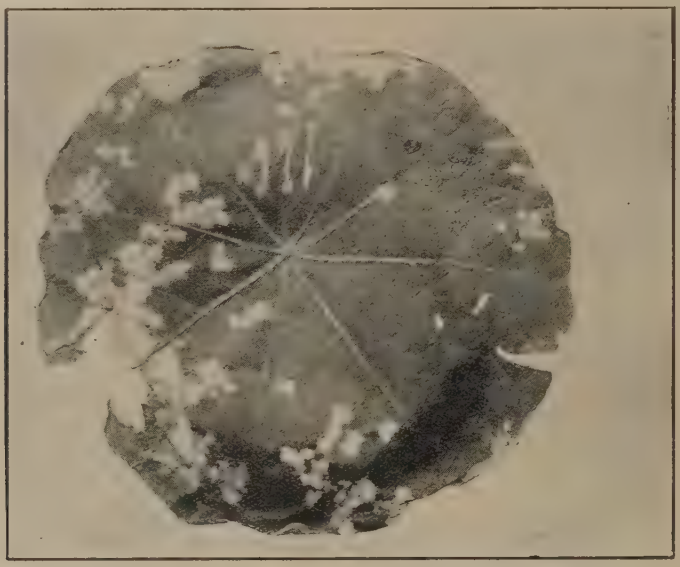


Fig. (Original.)
Leaf of plant showing typical injury caused by mite.

Kerosene emulsion.—Kerosene 2 gallons, soap 1 lb., naphthaline ½ oz. Dissolve the naphthaline in the kerosene. Shred and boil the soap in 1 gallon of water. When boiling, remove to another vessel, add kero-naphthaline and churn violently for several minutes until an emulsion is formed. This, upon cooling, will form a stock solution. When using, add 1 part of stock to 8 parts water.

Phenyle 1 part to 80 parts of water is a cheap and effective spray. This must not, because of its cheapness, be applied per medium of a watering can, a spray pump being necessary and only sufficient spray used, to contact with the mites. To saturate the seed bed with the phenyle solution is injurious to the young plants.

Dusting the seed beds with flaked naphthaline is a good repellant. This substance is insoluble in water and will not injure the plants.

Clensel 1 part to 60 parts water will kill the mite.

Katakilla will do likewise, using 1 packet to 3 gallons water.

Pysect, 1 part to 100 parts water is good.

Dusting with powder containing not more than a 3 per cent carbolic content is effective. Formula—1 lb. of 15 per cent. carbolic powder, mixed with 4 lbs. lime, tobacco dust or other inert carrier.

A good dusting powder is made as follows: —Half a kerosene tin of tobacco dust, half a kerosene tin of lime, ½ pint kerosene. Add the kerosene overnight and allow to permeate the mixture.

A band of creosote placed around a seed bed will prevent the mites from migrating into the young seedlings from outside sources.

THRIPS.

Several species of these insects are found upon tobacco foliage. They feed by rasping and sucking, for which purpose the mouth parts are formed.

Thrips respond readily to treatment when they can be reached by a spray.

Watch for any outbreak of this pest and spray with the black leaf 40 and soap mixture or any of the other contact sprays mentioned in this article.

SHEEP FEEDING EXPERIMENT.

MURESK AGRICULTURAL COLLEGE.

J. H. Riches, B.Sc.Ag. (Hons.).

INTRODUCTION.

As reported elsewhere, (1) in the summer and autumn of 1930 an experiment in the feeding of sheep for maintenance was carried out at the Muresk Agricultural College. The results obtained in this experiment seemed to be of sufficient interest to justify the carrying out of further investigations along the same lines; accordingly, in 1931, a further experiment of similar type was undertaken.

METHOD.

The site of the experimental paddocks was the same as in the previous experiment, and again lots of 20 sheep each were used, merino wethers being chosen for the experiment. The flock available to choose from consisted of one hundred and forty North-West and Murchison bred sheep, and were a fairly even line. They ranged in age from six-tooth upwards, but all had sound mouths, and were in fair condition. Although station bred, they had been depastured in the Avon Valley for about 12 months prior to the commencement of the experiment, and were apparently thoroughly acclimatised, and quite quiet.

As in the previous experiment, each sheep was numbered and weighed individually once a week (except when prevented by rain), and a careful record kept of all weights.

The experiment commenced on 25th February, and was continued for a period of just over 18 weeks until the 4th July—when green feed was becoming plentiful once more.

RATIONS.

Wheaten straw was again supplied in liberal quantities in an attempt to stimulate stubble conditions, and again farm grown feeds were used. As, in 1930,

wheaten chaff and silage, when fed alone, were found to be quite unsatisfactory, they were excluded from this experiment. Instead, two other rations were tried out, viz., oaten hay, cut fairly green, and wheat grain mixed with silage.

The rations, which were intended to be approximately equal in starch equivalent, are given in Table I.

TABLE I.

Ration Fed per Head.

Lot No.	25-2-31 to 13-4-31.				14-4-31 to 4-7-31.			
	Oats.	Wheat.	Hay.	Silage.	Oats.	Wheat.	Hay.	Silage.
1 ...	...	...	1¼lbs.	...	...	...	1⅝lbs.	...
2 ...	½lb.	...	...	...	⅝lb.	...	...	...
3 ...	¼lb.	...	...	1½lbs.	¼lb.	...	...	2 7/10lbs.
4 ...	⅜lb.	...	...	⅖lb.	⅓lb.	...	...	1 3/5lb.
5 ...	...	¼lb.	...	1½lbs.	...	⅜lb.	...	1½lbs.

It will be noted that the ration was changed on 14th April, 1931. This alteration was made owing to the fact that all lots were losing weight steadily and fairly rapidly. All rations were, therefore, increased approximately by half as much again.

The oats, wheat, hay and silage were all produced on the college farm. The oats were feed oats, rather thin, and containing a somewhat high percentage of weed seeds. The wheat was of fair average quality. The oaten hay was from a crop of Algerian cut shortly after flowering in 1930, and was a fair sample. The silage was made in 1930 from a crop of oats and peas, and was a good sample of acid brown silage, light brown in colour.

In Table II. are given the analyses of the various feeds, as determined by the Government Analyst from representative samples.

TABLE II.

Analyses of Feeds.

	Oats.	Wheat.	Hay.	Silage.
Moisture	9·05	9·71	9·38	68·90
Ash	3·80	1·58	5·13	1·69
Crude Protein	5·91	7·74	4·42	2·88
Ether Extract	4·98	1·24	1·96	0·86
Fibre	14·46	2·75	25·97	9·12
N. Free Extractives	61·80	76·98	53·14	16·55
	100·00	100·00	100·00	100·00

None of the rations were rejected by the sheep, except in the case of Lot 1, in which the hay was fed long and some of the thicker stems were not eaten; it was, however, impossible to ascertain the exact quantities.

Results.—The average weights of each lot at the beginning, and at each successive weighing period, are given in Table III.

TABLE III.

Mean Weight of Sheep in each Lot at successive Weighings.

Lot No.	25-2-31.	2-3-31.	9-3-31.	16-3-31.	23-3-31.	30-3-31.	14-4-31.	20-4-31.	27-4-31.
1	93·68	90·98	90·73	89·73	90·03	87·33	85·23	86·10	85·28
2	94·23	92·80	92·38	91·28	91·18	89·58	85·25	86·35	84·58
3	94·00	96·43	96·53	93·78	93·75	91·73	88·40	89·83	89·10
4	94·48	96·70	95·68	93·35	93·23	92·95	87·95	89·15	87·48
5	95·18	94·03	91·13	91·95	90·90	90·85	86·68	88·08	87·83

Lot No.	6-5-31.	18-5-31.	25-5-31.	1-6-31.	8-6-31.	10-6-31.	15-6-31.	22-6-31.	4-7-31.
1	84·90	82·80	81·15	82·33	80·78	...	80·33	80·90	79·58
2	87·30	84·30	84·95	84·13	83·20	...	82·73	82·80	82·00
3	89·10	88·65	88·90	89·43	89·53	...	89·20	88·38	88·38
4	88·88	86·78	88·45	86·50	...	87·20	86·83	87·93	86·30
5	88·13	87·13	88·18	88·90	...	88·45	88·90	89·03	88·63

In Table IV. are shown the mean percentage variations of each lot, at successive weighings, from the initial mean weights.

TABLE IV.

Variations from Initial Mean Weights.

Lot No.	2-3-31.	9-3-31.	16-3-31.	23-3-31.	30-3-31.	14-4-31.	20-4-31.	27-4-31.	6-5-31.
1	—2·70	—2·95	—3·95	—3·65	—6·35	—8·45	—7·58	—8·40	—8·78
2	—1·43	—1·85	—2·95	—3·05	—4·65	—8·98	—7·88	—9·65	—6·93
3	+2·43	+2·53	—0·22	—0·25	—2·27	—5·60	—4·17	—4·90	—4·90
4	+2·22	+1·20	—1·13	—1·25	—1·53	—6·53	—5·33	—7·00	—5·60
5	—1·15	—4·05	—3·23	—4·28	—4·33	—8·50	—7·10	—7·35	—7·05

Lot No.	18-5-31.	25-5-31.	1-6-31.	8-6-31.	10-6-31.	15-6-31.	22-6-31.	4-7-31.
1	—10·88	—12·53	—11·35	—12·90	...	—13·35	—12·78	—14·10
2	—9·93	—9·28	—10·10	—11·03	...	—11·50	—11·43	—12·23
3	—5·35	—5·10	—4·57	—4·47	...	—4·80	—5·62	—5·62
4	—7·70	—6·03	—7·98	...	—7·28	—7·65	—6·55	—8·18
5	—8·05	—7·00	—6·28	...	—6·73	—6·28	—6·15	—6·55

TABLE V.

Percentage Variation from Initial Mean Weights.

Lot No.	2-3-31.	9-3-31.	16-3-31.	23-3-31.	30-3-31.	14-4-31.	20-4-31.	27-4-31.	6-5-31.
1	—2·88	—3·15	—4·22	—3·90	—6·78	—9·02	—8·09	—8·97	—9·38
2	—1·52	—1·97	—3·14	—3·25	—4·95	—9·54	—8·37	—10·25	—7·36
3	+2·59	+2·70	—0·23	—0·27	—2·40	—5·94	—4·42	—5·20	—5·20
4	+2·35	+1·27	—1·19	—1·32	—1·62	—6·91	—5·64	—7·41	—5·93
5	—1·21	—4·26	—3·40	—4·50	—4·55	—8·93	—7·46	—7·72	—7·40

Lot No.	8-5-31.	25-5-31.	1-6-31.	8-6-31.	10-6-31.	15-6-31.	22-6-31.	4-7-31.
1	—11·02	—13·38	—12·12	—13·77	...	—14·25	—13·64	—15·05
2	—10·54	—9·85	—10·72	—11·71	...	—12·21	—12·14	—12·99
3	—5·68	—5·41	—4·85	—4·74	...	—5·09	—5·96	—5·97
4	—8·15	—6·38	—8·44	...	—7·70	—8·09	—6·93	—8·65
5	—8·45	—7·35	—6·59	...	—7·06	—6·59	—6·45	—6·88

Statistical Analysis.—In order to form an estimate of the significance of the differences between the various rations in their effect on live weight, it is necessary to treat the final results by statistical methods. Such an analysis shows that for odds of 20 to 1 against the difference being due to chance the significance difference is 4.16.

Reference to Table V. shows that the differences between Lot 1 and Lots 3, 4, and 5, and between Lot 2 and Lots 3 and 5 are all considerably greater than this, and are therefore definitely significant. The difference between Lots 2 and 4, while slightly less than 4.16, shows odds of over 10 to 1 against chance, so is probably also significant. The other differences may all be due to chance.

Table V.

Differences between Means.

Lot Nos.	Difference.	Lot Nos.	Difference.
1 and 2	2·145	2 and 4	4·075
1 and 3	9·10	2 and 5	6·285
1 and 4	6·22	3 and 4	2·88
1 and 5	8·43	3 and 5	0·67
2 and 3	6·955	4 and 5	2·21

Observations.—An inspection of Table IV. brings out a number of points:—

(1.) There is a distinct difference between Lots 3 and 4 and Lots 1, 2, and 5 in the first week. The only explanation of this which suggests itself is that the sheep in pens 3 and 4 may have obtained somewhat more nutritive value than did the others from the dry grass and herbage in the pens. As, however, this was not very extensive, and as 20 sheep had been held in each pen prior to the commencement of the experiment, it appears unlikely that this could have produced the effect noted.

(2.) After the first week there was a fairly consistent and rather rapid fall in weight in all lots. This led to the conclusion that, although unlimited wheaten straw was provided, all rations were inadequate to supplement this, and on the 14th April they were all increased by half. This alteration had the desired effect of arresting the rapid general loss in condition.

(3.) The rations appear to be divided into two fairly distinct groups:—

(a) Rations 1 and 2, the unmixed dry feeds.

(b) Rations 3, 4, and 5, the mixed feeds containing silage.

It will be noted that after the increase in the rations there was still a steady decrease in weight in Lot 1 and to a less extent in Lot 2, and this, in spite of the fact that Lot 1 were rejecting part of their ration.

Discussion.—Reference to the statistical analysis of the results will show that the difference between Lot 1 and Lots 3, 4, and 5, and between Lot 2 and Lots 3 and 5 are definitely significant, while the difference between Lot 2 and Lot 4 is very probably also significant. In the case of the other pairs of lots, the differences may be due to chance, and cannot be regarded as of any significance.

As in the previous experiment (1), a study of the analyses of the feeds seems to supply an explanation of the grouping noted above. Working on the same assumptions as previously, the starch equivalent and nutritive ratio for each ration were calculated, and these figures are presented in Table VI.

Table VI.

Starch Equivalents and Nutritive Ratios.

	Lot No.				
	1. Oaten Hay.	2. Oats.	3. Oats + Silage.	4. Oats + Silage.	5. Wheat + Silage.
S.E.—					
1st Period ...	·56lbs.	·31lbs.	·36lbs.	·32lbs.	·38lbs.
2nd Period ...	·84lbs.	·46lbs.	·54lbs.	·48lbs.	·57lbs.
N.R.	16·2	14·5	10·3	11·8	10·4

As before, it will be seen that there is no obvious connection between starch equivalent and changes in live weight, but in the case of nutritive ratios, the correlation is most marked. It will be noted that the nutritive ratio of all rations is fairly wide, but if the rations are arranged in order from the narrowest to the widest, viz., 3, 5, 4, 2, 1, they are seen to stand in the same order as when arranged accordingly to losses in live weight.

This marked relationship bears out the observation made in the 1930 experiment, that lack of protein is the limiting factor rendering some supplements unsatisfactory.

It will be noted that oats alone in the 1931 experiment did not give nearly as good results as in 1930, but a comparison of the analyses anl nutritive ratios of the two samples immediately makes this clear, the 1931 sample being considerably lower in protein and higher in fibre than was the case in 1930 (see Table VII.).

Table VII.

Analyses and Nutritive Ratio of Oats.

	1930.	1931.
Protein	9·58	5·91
Fibre	11·03	14·46
N.R.	8·8	14·5

One of the main lessons to be drawn from the experiments, therefore, would seem to be that a ration supplementary to dry feed should be fairly high in protein.

Costs.—Turning now to the important question of the cost of the various rations. As before, no reliable figures are available for Western Australian conditions, so figures are again taken from Turretfield, South Australia (2) for oats, wheat, and hay, and a figure calculated on a general average in the case of silage.

The figures taken as representing the average cost are as follows:—

Oats, per bushel—2s. 7d.
Wheat, per bushel—4s. 10d.
Cereal hay, per ton—£2 19s. 6d.
Silage, per ton—17s.

The Turretfield figures may perhaps be criticised as being unduly high, but it must be remembered that rent, interest on capital, and wages of manager and staff are all included in this figure. In any case, costs of production will vary from farm to farm, and it is impossible, therefore, to give an exact figure to fit all cases.

From the above figures the cost per lot per day, and for the whole period after the increase in rations, have been calculated, and the results are presented in Tables VIII. and IX.

Table VIII.

Cost of Rations per Lot of Twenty Sheep per Day.

Lot No.	Oats.	Wheat.	Hay.	Silage.	Total.
	d.	d.	d.	d.	d.
1	...	...	11·95	...	11·95
2	11·63	...	...	...	11·63
3	3·10	...	...	4·92	8·02
4	8·53	...	...	1·64	10·17
5	...	7·25	...	3·28	10·53

Table IX.

Total Cost of Rations, 14–4–31 *to* 4–7–31.

Lot No.	Cost.
	£ s. d.
1	4 1 8
2	3 19 6
3	2 14 10
4	3 9 6
5	3 11 11

At the prices quoted it will be seen that the rations incorporating silage are the lowest in cost, while oats alone and oaten hay are the two dearest, the latter owing to the fact that it was fed in relatively greater quantity than the other rations. It is also worthy of note that the ration, including wheat, compares quite well with the rations containing oats. Taking live weights into consideration, it again definitely appears that a mixture of silage and cereal grain is the most suitable supplement for maintenance of sheep on dry stubble.

Wool.—At the close of the experiment all the sheep were examined by a competent woolclasser for any change in growth.

In Lot 1 there was a definite fining off of the fibre in several sheep; in Lot 2 there was little change, while in Lots 3, 4, and 5 there was evidence of slightly more character in the wool.

Health.—The health of all the experimental animals was good throughout.

SUMMARY AND CONCLUSIONS.

1. Experiments were carried out in the supplementary feeding of sheep with five lots of twenty sheep each. The experiments commenced on the 25th February, and covered a period of just over eighteen weeks ending on 4th July. No sheep died during the experiment.

2. The rations tested were—oaten hay, fed long; oats; oats, plus silage, with a small amount of oats; oats plus silage, with a larger quantity of oats and a proportionately smaller amount of silage; and wheat, plus silage. The amounts fed were calculated to be approximately equal in energy value, and were fed as a supplement to a basal ration of wheaten straw.

3. Of these five rations, oats, plus silage, with the smaller proportion of oats, and wheat, plus silage, gave the best results, followed closely by the other, oats, plus silage ration. Oats alone was not so good, while oaten hay was the worst of the five.

4. As in the 1930 experiment, it seems almost certain that the factor limiting the value of certain of the rations is the protein content. This would explain the divergent result obtained with oats in the two years, the sample used in 1931 being much inferior in quality to and lower in protein content than the 1930 sample.

5. On the basis of the prices quoted, the two rations, including oats and silage, are the cheapest, while wheat, plus silage, is little more expensive. Taking account of the results in both 1930 and 1931, it seems safe to say that with silage of fair to good quality, a mixture of silage with fair average quality wheat or oats is a satisfactory supplement. Oats, if of poor quality, may not be a good supplement if fed alone; but oats of good quality would be quite satisfactory.

It will be seen, therefore, that in the case of the differences between Lot 1 and Lots 3, 4, and 5, and between Lot 2 and Lots 3 and 5, the odds are more than 100 to 1 against thse differences being due to chance.

In the case of the other differences, the odds against their being due to chance are all less than 20 to 1, so that they cannot be regarded as being definitely significant. For the difference between Lots 2 and 4, however, the odds are over 10 to 1, so that it is probably not due to chance:

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TESTING MILK FOR BUTTER FAT WITHOUT THE USE OF A CENTRIFUGE.

By A. B. Adams, B.Sc.Agr.

A method of determining the percentage of butter fat in milk without the use of a centrifuge was reported by B. Singh, in the Jour. Cent. Bureau of Animal Husbandry and Dairying, India, Vol. 2, No. 4. The following is an abstract: –

"In this method of testing milk for fat 11 c.c. of milk are placed in a Gerber tube and 5 c.c. of Fehling solution B added. One c.c. of a mixture of 55 parts of

isobutyl alcohol and 45 parts of methyl alcohol is added, the tube corked, inverted, shaken gently and the tube is then almost completely immersed in a water bath at 80 C. The tube is removed from the bath when the liquid inside is a deep orange, shaken and replaced in the water for three minutes. The cork is then removed, 5 c.c. of hot water poured down the sides of the tube, the cork is replaced, and the tube inverted gently and again placed in the water bath. In a short time the fat column appears and is easily read on the graduated scale."

As the quantities of reagent used in the method above reported are for use with Gerber bottles and as such bottles are not in general use in this State, the writer experimented with the method, using Babcock bottles and adjusting the quantities of the reagents to the larger quantities of milk used in the Babcock bottles.

Fehling solution B is the alkaline solution; it is prepared as follows:—

173 grammes of sodium potassium tartrate (Rochelle salt) and 51 grammes of sodium hydrate are dissolved in 500 c.c. of distilled water or rain water.

The following procedure was adopted when testing milk in Babcock bottles by this method:—

17.6 c.c. of the milk were pipetted into the bottle and to this were added 8 c.c. of Fehling's solution B and 1.6 c.c. of the mixture of 55 parts of butyl alcohol and 45 parts of methyl alcohol. The mixture was then gently shaken until the casein appeared to be dissolved. The bottle was then placed in a water bath at 80deg. C. (An empty 5lb. jam tin, one of the tall type, is very suitable as a water bath as it is about the same height as the test bottles.) The temperature must be maintained at 80deg. C. (176deg F.). When the liquid in the test bottle is a deep orange, but not before, the bottle is removed from the water bath, shaken and replaced in the water bath for three minutes. Hot water was then added to bring the liquid to the bottom of the neck, after standing in the water bath for two minutes a second portion of hot water was added to the test bottle to bring the fat into the graduations in the neck of the bottle. It was then allowed to stand in the water bath for three minutes and then removed and the percentage of fat read off.

The writer checked this method by comparing it with the usual Babcock test, *i.e.*, adding 17.5 c.c. of sulphuric acid to 17.6 c.c. of milk, shaking the mixture until the casein is dissolved, centrifuging for five minutes, adding hot water to the bottom of the neck of the test bottle, centrifuging two minutes, adding hot water to bring the fat column into the neck of the bottle and centrifuging for another minute. Then removing the bottles from the centrifuge and placing them in a water bath at 180deg. The results obtained without the centrifuge proved to be comparable with those by the Babcock test.

As a further check, when Mr. Ruthven, the Government Herd Tester, was paying his usual monthly visit to Muresk College, the writer tested some of the milks that were under official test and obtained comparable results.

If a burette for the measurement of the reagents is not available a minim measuring glass may be used, taking 135 minims of the Fehling's and 27 minims of the alcohol mixture.

N.B.—In using the method the water in which the test bottles are immersed must be maintained at 176deg. F. The hot water must not be added to the test bottles until the liquid has become a deep orange colour.

It is not suggested that the method has any greater accuracy than the Babcock method nor that it would have any advantages over that method in the factory. For testing a few animals on the farm, however, the small amount of apparatus required and the elimination of acid, also the fact that the water bath can be placed on the stove and attended from time to time in place of centrifuging, are distinct advantages.

HOME SCOURING OF WOOL.

H. McCallum, Sheep and Wool Inspector.

The main factors in successful scouring of small lots of wool are:—

Good supply of water—rain-water for choice.

Good soap, potash preferable, or non-alkaline.

Use of warm, not *hot* water.

Quick draining and drying.

No wringing or twisting of wool.

All wool should be well shaken to remove loose dust. Very stained and dirty pieces must be removed. Commence on the cleanest wools.

Prepare liquor by first shredding soap into a small quantity of hot water and thoroughly dissolving, allowing about 8 ozs. of soap to 4 gallons of water.

Three tubs are necessary. In the first two mix the prepared soap liquor with warm water at about 115 degrees Fah., and in the third use clean warm or cold water. The soapy waters should have a soft feeling and give a nice lather without becoming all suds. Wool that has been hard pressed should be opened up and allowed to stand for a short time before putting into the bath. Only sufficient wool to be well covered with water should be put in at one time. Keep wool moving in the bath for five to ten minutes, lift out on to draining board, squeeze, and put into the second tub—repeat process and then rinse in the third tub. All traces of soap must be removed. Squeeze out as dry as possible, shake out lightly, and then place out on racks of netting or calico sheets to dry. Choose a fine warm day and place the racks out of the direct rays of the sun, but in a position where there is a good draught of warm air. Turn the wool frequently to facilitate drying, as the quicker the moisture is removed the better will be the quality of the finished product, but great heat must not be used for this purpose. The wool must not be twisted or wrung.

The potash content of the wool yolk materially assists in the scouring, and the drainings from the first and second tubs should be permitted to run back. The temperature of the water must be kept even and a little more of the prepared liquor added and well mixed before each lot of wool is put through. After several lots of wool have been washed, the rinsing water can be added to that in the first and second tubs and a fresh lot used for rinsing.

Very greasy, dirty pieces require the first and second waters slightly hotter, but at no time must water be used for washing wool hotter than the hand can be borne in. The third tub may be of warm clean water, and the final rinse can be cold.

For very hard water caustic soda powder, 1 oz. to 8-10 gals., may be added to the first washing water.

Rinsing of all wools may be carried out in a running stream.

The handling of locks and pieces will be facilitated if "holders" are constructed to fit inside the tubs. These should have perforated bottoms and holes at the sides and be a few inches smaller than the tub, so that the water can move around the sides and come up through the bottom. Wooden boxes with the tops and bottoms removed and wire netting fixed across the bottom opening give satisfactory service. Wire baskets are also very suitable.

If an ordinary clothes wringer or mangle is available it will provide a very quick and satisfactory means of squeezing out the water between the washings and prior to spreading out to dry. A long piece of calico, butter muslin, or similar material, twice the width of the wringer or mangle, will be found of value if folded double and the wool placed between, as it prevents the fibres winding round the rollers.

THE VALUE OF HONEY AND ITS USE.

H. Willoughby Lance, Apiculturist.

Few persons realise the variety of purposes for which honey can be used with advantage. The common idea seems to be that honey should be eaten on bread, and that occasionally as a change from other food and as a relish. As a matter of fact, honey should be part of the daily diet of the majority of persons.

Sugars of various kinds are what are termed carbo-hydrate foods and are heat and energy producing, and a certain amount of such food is necessary daily, if the body is to function properly. Sugars (of which there are many forms), however, cannot be assimilated by the body and passed into the blood stream until their chemical formation has undergone a change. With the majority of sugars, this change has to take place in the stomach of the person eating the sugar. This process must necessarily use up some of the juices of the stomach.

It is, therefore, quite clear that if we can introduce the necessary sugar into the stomach in its changed state, scientifically known as "inverted," we shall save the stomach much work and the juices will be available for other purposes. Ordinary refined white sugar is not "inverted." Nectar, as it is gathered from the flowers, is a sweet sugar syrup, which is inverted by the field bees when carrying it home to the hive in their honey sac and storing it in the honey cells. The complete inverting and ripening takes place in the honey comb, and it is not until the ripening is completed that the bees cap the cells over with wax.

Nature has provided for the sustenance of the bees in a wonderful way. The honey stored in the hive is their winter food, when nectar straight from the flowers is not available. It must be remembered that bees in most countries cannot gather honey during the cold wet weather, and in many cases are confined to the hive for several months. During this period it is important that the stomach of the bees should have as little work to do as possible, so that they may remain in a semi-dormant state. If their food were stored in the form of nectar, the eating of it would use up energy; whereas, being already inverted, it is ready for immediate assimilation. Also, if it had not been ripened, it would have fermented and caused intestinal trouble and disease.

The bees having done the necessary work in their own interests, it is for us to take advantage of it and to use honey instead of cane sugar, whenever possible. It must also be remembered that cane sugar is nothing but sugar, whereas honey contains many of the mineral salts required by the human system, amongst them being phosphoric acid, iron, lime, potash, soda, etc., the proportion of each varying according to the source of the honey.

Honey, in addition to being an important food, also has great curative and medicinal value. It is also the one food in which no disease germs, that attack the human system, can exist. Honey is the best food with which to start the day. Anyone commencing the morning meal with porridge, "Weeties," or other prepared cereal food, should drizzle honey over it in place of sugar. Very few persons will desire to go back to sugar.

A generous supply of an easily digested carbo-hydrate food is considered to be the best stimulant in cases of acute fever, prolonged anesthenia, for a short fast, mountain climbing and athletics, or any physical emergency. The following extract from the "West Australian" of August, 1931, proves the value of honey as a sustaining food:—

SUSTAINED BY HONEY.

Himalayan Climbers' Experience.

LONDON, Aug. 2.—The British Himalayan Expedition has sent a letter to the New Zealand Honey Board from the expedition's camp in Sikkim, stating that it has returned to its base on the completion of successful research work in the Himalayas. Once, the letter states, the party *lived for* 10 *days solely* on New Zealand honey, owing to their supplies having been raided. The looters fortunately missed seven jars of honey, packed in a haversack.

We will first deal with Honey in Cooking, giving a few recipes, and then give information of other uses.

HONEY FOR COOKING.

When using honey in the place of sugar for cooking, it must be remembered it cannot be used in exactly the same way as sugar. Honey contains a certain proportion of water, sometimes as much as 18 per cent., so that its sweetening value is often less than sugar, and yet in some cases less honey is required than sugar, some honeys being sweeter than others and having more flavour. It may be necessary, therefore, to vary somewhat the quantity of honey given in the recipes according to taste.

Honey cooking requires somewhat more care than usual as honey burns quicker than sugar. It must be remembered that there are many different flavours in honey and that the constituents vary, consequently the honey that is suitable for one kind of cooking may not be so suitable for another. For instance, for a honey sponge, a light-bodied mild flavoured honey is best, but for ginger nuts a dark, heavy, strong-flavoured honey is excellent.

When honey becomes granulated, it can be made liquid again by standing it in hot water at not more than 140deg. F., or just as hot as the hand will bear. If it is placed over a fire or flame, the jar or tin should stand on a piece of wood in the receptacle containing the water, otherwise the flavour will be spoilt. The quicker it is cooled after heating, the longer it will remain in liquid form.

The following are a few simple recipes which have all been tested out:—

Nut Bread Roll—

1 cup finely cut nuts;
½ cup honey.

Blend to form a spreading paste. Cut bread in slices full length of loaf. Spread bread with butter, then with paste, and roll as for jelly roll. Wrap each roll in waxed paper and tie to keep intact. Let stand one hour or longer, remove paper, and cut each roll in three slices. Each loaf makes 15 rolled slices.

Fruit Cake:—

Warm ¼ lb. nut lard and ½ lb. honey, add 2 well beaten eggs; small quantity cinnamon and nutmeg; 6 ozs. raisins; 6 ozs. currants, and sufficient flour to make a stiff batter. Well stir, drop into hot gem pans and bake in slow oven.

Honey Cake—

1 lb. self-raising flour;
½ lb. butter;
½ lb. raisins;
½ lb. mixed peel;
4 tablespoons honey;
Milk—about 1 gill;
2 eggs;
2 tablespoons sugar;
Pinch of salt;
Grated rind of a lemon.

Method.—Sift flour and cream butter with sugar; warm honey in milk. Mix all dry ingredients together, gradually add butter and sugar, milk and honey, and well beaten eggs. Place in papered tins and bake in moderate oven for about 2 hours.

Ginger Cake—

¼ lb. butter or lard;
½ lb. honey;
2 eggs;
1/3rd pint sour milk;
2 ozs. finely chopped preserved ginger.

Mix and add gradually two cups flour, beating well all the while. Line tin with greased paper and pour in mixture. Bake in moderate oven 40 minutes.

Honey Shortcake—

½ lb. flour, add 1 teaspoon baking powder. Rub in ¼ lb. nut lard or butter, 4 ozs. honey. Make into a paste with about 1/3rd pint milk. Roll out, cut into desired shape, and bake in hot oven.

Raisin Cake—

1 lb. self-raising flour;
½ lb. butter;
½ lb. raisins;
½ lb. mixed peel;
4 tablespoons honey;
About 1 gill milk;
2 eggs;
2 tablespoonsful sugar;
Pinch of salt;
Grated rind of lemon.

Sift flour and cream butter with sugar, warm honey in milk. Mix all dry ingredients together, gradually add butter and sugar, milk and honey, and well beaten eggs. Place in papered tins and bake in moderate oven about 2 hours.

Honey Gems—"A"—

6 ozs. honey;
1 pint sour milk.

Well mix with egg whisk, adding a little at a time, sufficient flour to make into soft dough. Flavour as desired, drop in hot gem pans, and bake 20 minutes.

Honey Gems—"B"—

1 egg;
2 cups flour;
2 teaspoons baking powder;
1 cup cold water;
½ cup sugar;
Flavouring.

Method.—Well beat egg, sieve flour and baking powder, add butter, sugar and honey, essence, then add water. Stir well, drop in spoonfuls on baking dish or tray. Bake 10 minutes.

Honey Sponge Sandwich—

1¼ cups flour;
2 eggs;
¾ cup honey;
2 tablespoonfuls butter;
2 tablespoonfuls hot water;
½ teaspoonful baking soda.

Beat butter to a cream, add eggs not previously beaten, dissolve soda in hot water, then mix well with the honey which has been previously warmed, add it to the above ingredients, lastly add the flour and flavouring. Bake to a golden brown for about 10 minutes. Form into a sandwich with honey-lemon butter.

Gingernuts—

1 cup strained honey;
1 cup sugar;
½ cup melted butter;
1 egg;
2 teaspoonfuls baking powder;
2 teaspoonfuls ginger;
2 cups flour;
1 cup chopped nuts.

Mix honey, sugar, melted butter and beaten egg. Sift baking powder and ginger with flour. Add nuts to flour after sifting. Stir well into other ingredients. Bake in moderate oven 25 minutes.

Honey Pudding—

1 oz. cornflour;
4 ozs. honey;
5 ozs. breadcrumbs;
2 ozs. butter;
Grated rind and juice of ½ lemon;
1 gill milk;
1 egg.

Boil milk, pour on the cornflour, previously blended with a little water. Return to saucepan and cook eight minutes. Add butter and yolk of egg, beating in thoroughly. Put breadcrumbs and grated lemon rind into basin. Stir in honey, warming if necessary, then cornflour, sauce, and lemon juice, and lastly stiffly beaten white of egg. Pour into butter mould. Steam 1 hours. Serve on hot dish with melted honey.

Apple Pudding—

Stew 3 or 4 apples, using honey to sweeten.
¼ cup honey;
2 eggs;
2 tablespoonfuls butter;
1 cup self-raising flour.

Butter a mould and put mixture in tablespoonful and pieces of apples in layers. Fill up in this way. Cover and steam 1½ hours. Serve with sauce made of:—

1 dessertspoonful cornflour;
1 egg;
1 dessertspoonful honey;
1 cup milk;
Flavouring to taste.

PIES.

Orange Tart or Pie—

2 dessertspoonfuls cornflour;
Juice 2 oranges;
1 lemon;
2 tablespoonfuls honey;
Yolk 3 eggs beaten.

Lime plate or dish with honey pastry. Bake. Mix cornflour with cold water and add 1 cup boiling water. Stir in orange and lemon juice and honey. When boiling add egg yolks. Stir until thick. Then put this on pastry. Beat whites of eggs stiffly with a little honey added. Spread roughly on pie and bake slightly (just enough to set).

Pumpkin Pie—

¾ cup honey;
3 eggs;
1 teaspoonful ginger;
1 teaspoonful cinnamon;
1 tablespoonful butter;
1¼ cups cooked mashed pumpkin.
1 teaspoonful salt;
1 teaspoonful flour;
½ teaspoonful corn starch.
1½ cups milk.

Sift dry ingredients. Then beat in eggs lightly. Slightly warm milk and blend with honey. Add to egg and flour mixture and stir until smooth. Pour into plate lined with pastry or make individual pumpkin tartlets. Just before pie is served top with honeyed whipped cream.

MIXED FRUIT SALAD.

Diced fresh fruit, orange, apple, banana, pears, peaches, apricots, pineapples, cherries, grapes, or lettuce with a little honey drizzled over it.

Orange Krisp Salad—

3 large oranges;
Honey;
Rice krispies or puffed rice, or cocoanut;
Lettuce.

Peel oranges, cut into slices crosswise, and remove centre core. Have honey in flat bowl or saucer and set on top of teakettle or in warming oven so that it becomes slightly warmed. Dip orange slices in warm honey and then in saucer of rice krispies or puffed rice, or cocoanut, so that both sides will become coated. Allow four or five slices to a salad, arrange on individual beds of lettuce, and garnish with dots of cherry pieces.

COOKED FRUITS.

Honeyed Apples or Pears—

Wipe well with damp cloth, remove cores. Place in casserole or pie dish. Put 1 dessertspoonful of honey in centre of each apple or pear. Bake slowly until skin cracks and apples are tender. Baste well with honey once or twice during cooking. Serve hot or cold in dish in which they were cooked.

SAUCES, ETC.

Sauce for Puddings—

2 tablespoonfuls honey;
1 tablespoonful water;
Juice and grated rind of ½ lemon.

Boil one minute.

Salad Dressing—

1 tablespoonful candied honey;
2 tablespoonfuls thick sweet cream;
1 tablespoonful vinegar;
¼ teaspoonful mustard.
Pepper and salt to taste.

No cooking. Beat together. Excellent over salad made from chopped apples and celery.

SWEETS.

Honey Toffee—

No. 1 Recipe: Boil honey until it hardens when dropped in cold water. Pull until it becomes white. A pound requires about 20 minutes boiling and stirring. Great care must be exercised not to burn the honey.

No. 2 Recipe:

2 cups sugar;
1 tablespoonful vinegar;
½ cup honey;
1 tablespoonful cold water;
1 tablespoonful butter.

Boil ingredients for about 20 minutes and test for hardness.

No. 3 Recipe:

1 cup honey;
1/3rd cup cold water;
1 cup sugar;
1 teaspoonful vanilla.

Boil water, sugar and honey together and test for hardness. Then add vanilla. Put on buttered dish to cool, then pull until white. If pan in which honey is cooked is buttered around the top it will not boil over.

Honey Jubes—

1 cup water;
1 large lemon;
1 cup honey;
1½ ozs. gelatine.

Dissolve gelatine in hot water, add honey that has been previously warmed, also lemon juice. Stir till thoroughly mixed, put away till cold, when it can be cut to desired size.

Nut and Honey Drops—

¾ lb. sugar;
2 ozs. nuts;
4 tablespoonsful condensed milk;
2 tablespoonsful honey;
White of 1 egg;
3 tablespoons cold water.

Put sugar, condensed milk and water into pan and heat until temperature of 223deg. is reached. Add honey and cook to 240deg., then take from fire and add beaten whites. Beat one minute and add chopped nuts. Place in spoonsful on waxed paper.

Honey Caramels—

1 lb. honey ;
1 lb. sugar;
3 tablespoonsful new milk;
Flavour with vanilla.

Boil until it hardens when a small portion is dropped into cold water. Pour into greased shallow dish, as it cools, cut into desired shapes and wrap in grease-proof paper.

HONEY DRINKS.

It is not generally realised that honey makes an excellent stimulative drink, made either with hot or cold water. One objection to using honey in cold drinks is that it takes some time to dissolve. This may be got over by making it into a—

Honey Syrup by dissolving two parts of honey in one part of hot water. This may then be bottled and is ready for use the same way as raspberry or other fruit syrup. This will keep good without fermenting for many weeks.

Honey Lemon Drink—

The juice of half a lemon and one or two dessertspoonsful of honey syrup, according to taste, in a glass of water.

Honey Orange Drink—

The juice of one orange and one or two dessertspoonsful of honey syrup, according to taste, in a glass of water.

Vitality Cocktail—

2 oranges (juice);
1 egg (yolk);
½ lemon (juice);
2 tablespoonsful honey.

Beat all together and drink each morning.

Cocoa, Coffee, and Chocolate—

Each is improved by using honey in the place of sugar.

Ginger Beer—

5 lbs. sugar;
½ pint lemon juice;
5 gallons water;
½ lb. honey;
5 ozs. bruised ginger.

Boil ginger half an hour in 3 quarts of water, add sugar, lemon, and honey, with the rest of the water. Strain through a cloth. When cold add white of an egg, 1 teaspoonful essence lemon, small teaspoonful essence ginger. Stand in a cask four days and then bottle.

Honey Beer—

40 lbs. honey for strong beer;
30 lbs. honey for mild beer;
2 lbs. hops for bitter beer;
1½ lbs. hops for sweet beer;
2 lbs. extract of malt;
1 cup brewer's yeast, or 1 cake (2 ounces) compressed yeast.

Place hops in muslin bag and boil in water for half an hour in a clean copper, if available. Strain off liquid and pour hot into keg, which has had honey and malt previously added. Stir until all is dissolved, then add cold water to fill keg within one inch of bung hole. Add yeast when contents are luke warm. By next day fermentation should have set in and be flowing well over keg. This lasts about a week or ten days in warm weather. As the contents of barrel subside, add a little water daily to keep it full. This enables sediment to work over, instead of going back into beer. When action has stopped, cork up tightly, and leave about two weeks or longer. Then the beer is ready to drink or bottle. Bottled beer is better than draught, as it has a fine head when opened, and is not liable to go sour. Capsule tops are preferable to corks.

Honey Mead—

Beuhne's recipe is:—60 lbs. honey, 18 lbs. raisins; boil 10 or 15 minutes in water sufficient to fill an 18-gallon barrel; ½ pint yeast. Let it work for two or three weeks, paste a piece of cheese cloth over the bung to keep out vinegar flies. It will boil or hiss for two or three months (according to the amount of honey used). Then, when it is perfectly quiet bung up tightly for seven to twelve months —the longer the better. If no raisins are used, then up to 90 lbs. honey had better be used. Clearing can be done with white of eggs or a packet of isinglass.

MEDICINAL.

Honey is a most excellent remedy for many ailments, and a few of its uses are given hereunder:—

Asthma—

1 oz. castor oil;
4 ozs. honey.

Mix and take one tablespoonful night and morning.

Colds—

Juice of half a lemon;
1 or 2 teaspoonsful of honey.

in glass of hot or cold water. Take night and morning and at intervals if necessary. One of the best medicines for colds, influenza, and many kinds of fever.

Ointment—

Honey and flour mixed into thin paste, warmed, spread on linen rag and applied to piles, abscesses or boils, quickly brings them to a head and lessens the tension and pain.

Salve—

2 tablespoonsful of honey;
Yolk of one egg;
Sufficient flour to make into paste.

Excellent for running sores of long standing, boils, or sores with proud flesh.

Borax Gargle for Sore Throat—

1 teaspoonful of borax;
2 teaspoonsful of honey;
1 glass of water.

Mix together and gargle frequently.

Honey and Vinegar for Sore Throat—

Equal quantities of honey and white vinegar or honey vinegar by preference. Warm the honey and stir vinegar into it. Put into bottle and cork. Specially soothing for coughs and colds, and delicious to taste.

For Croup—

Honey is an excellent remedy, giving sure and excellent relief.

For Burns—

A paste of honey and soda, spread on the burn and covered with cotton wool and cloth, quickly relieves the pain.

For Piles—

Honey spread on the place and covered with cotton wool and cloth is an excellent remedy.

For Sleeplessness—

Two teaspoonsful of honey dissolved in a glass of hot milk and sipped slowly is an excellent sleep producer. It has succeeded where other methods fail.

The above uses and recipes are only a few of the many ways in which honey plays an important part, but it is impossible, without writing a large book, to give them all or explain all that is known about the sources and value of honey.

LINSEED OR "FLAX" AND ITS CULTIVATION.*

Geo. L. Sutton, Director of Agriculture.

The "flax" referred to is that which produces the grain, known as linseed, and the fibre from which linen, canvas, duck and strong cordage is produced. Botanically the plant is known as *Linum usitatissimum*. It is an annual, and is quite distinct from "New Zealand flax," which is a perennial, and botanically known as *Phormium tenax*, and which is used for the manufacture of rope and twine.

The principal use for the grain produced by this plant is the manufacture of linseed oil, which is so largely used for mixing with paints. The grain contains from 25 to 40 per cent. of oil. It is a valuable food for horses, cows and calves, and is specially valuable for supplementing the skim milk fed to calves. Because of the oil it contains it is a laxative, and this makes it specially useful in cases of illness. It should, however, be used sparingly. Because of the high commercial value of the oil in the linseed grain, the whole grain is rarely used as a feed for stock. After the oil is extracted from the grain a residue is left which is known as Linseed Cake, Linseed Nuts, or Linseed Meal, which is an excellent stock food. As a source of protein for stock, it is more valuable than the whole grain, and is easily and thoroughly digested. Its qualities are extolled thus by Henry and Morrison† : "There is no more healthful food for limited use with all farm animals than linseed oil-cake or oil meal, with its rich supply of crude protein, slightly laxative oil and its mucilaginous soothing qualities. Its judicious use is soon apparent in the pliable

* Flax and its Cultivation—Geo. L. Sutton, 1919; Bulletin 58—Revised and reprinted.

† Feeds and Feeding, 1917—Henry and Morrison.

skin, the sleek oily coat and the good handling quality of the flesh of the animals receiving it. It is, therefore, most useful as a conditioner for run-down animals." A small amount of linseed meal is helpful in the rations for horses and dairy cows.

The composition of linseed and linseed meal are given in Table 1 hereunder*:—

Table I.

	Digestible Constituents.					
	Crude Protein.	Pure Protein.	Oil.	Carbo-hydrates.	Fibre.	Nutritive Ratio.
Linseed Cake ...	10·4	18·1	34·7	18·3	1·8	1 : 5 . 5
Linseed Cake—English Made	25·3	23·9	8·7	28·5	4·3	1 : 2 . 2
Linseed Cake—Foreign	27·8	26·3	9·1	25·8	4·3	1 : 2 . 0

Because of its high protein content and consequent narrow nutritive ratio, linseed cake, linseed nuts or meal is a very suitable complement for mixing with more carbonaceous concentrates like maize, barley, wheat, and oats when the food is required for milking cows. In a mixture of linseed cake and oats in equal parts, the proportion of digestible protein to the other digestible nutrients is similar to that in bran. The food value of the mixture is greater, however, than an equal weight of bran, 100 lbs. of the oats and linseed mixture being equal to 160 to 170 lbs. of bran.

Grain can be produced under warmer and drier conditions than can good fibre of satisfactory length, and it is likely that satisfactory grain crops can be obtained in many parts of the Wheat Belt, even if flax for commercial fibre cannot be grown there.

In the 1919-20 season farmers' trials with flax were conducted throughout the State. It was found that the sowing, through unavoidable causes, had on the whole been on the late side, and the seed, which had to be imported, proved very weedy. Despite these two set-backs there was sufficient evidence to show that flax with long enough fibre can be produced in this State. It is apparent that farmers accustomed to grow wheat, oats, or potatoes by clean and careful methods, can grow flax, but their methods must be better than the average.

The trials with fertilisers indicated that on soils of average fertility, the usual dressing of superphosphate was all that was required. On other soils an application of a nitrogenous fertiliser produced longer crops. The linseed grain produced appeared less plump and bright than the imported Victorian sample, but on analysis the oil content proved to be very similar. The analysis of six samples of grain submitted to the Government Analyst and Agricultural Chemist for oil determination were as follow:—

Grain grown by—	Percentage of oil.
Victorian (imported)	37.47
P. Duggan, Northam	35.62
Chapman Experiment Farm	35.78
P. Boucant, Boyanup	34.59
E. Gee, Highbury	39.22
C. Atheron, Lowden	38.08

* The Composition and Nutritive Value of Feeding Stuffs—T. B. Wood, M.A., and T. T. Halnan, Cambridge University Press.

The straw produced was sufficiently long for commercial purposes, and though it was not possible to ascertain definitely the quality of the fibre produced, there is no reason to believe that its quality was other than satisfactory.

In view of the result of these trials and subsequent experience, there is every reason to expect that linseed for grain can be grown satisfactorily and profitably in Western Australia, and that at least sufficient for the State's requirements should be produced.

In Table 2 will be found details furnished by the Government Statistician relating to the importation of linseed and linseed products in Western Australia as at 30th June, 1930:—

Table 2.

Linseed and Linseed Products imported into W.A. for the year ending 30th June, 1930.

	Quantity.	Total Value.
		£
Linseed ... ... centals	1,087	1,019
Linseed Meal ... ... ,,	7,693	4,791
Linseed Cake, Nuts, etc. ... ,,	12,256	7,587
Linseed Oil ... ... gallons	64,053	16,061
		£29,458

Based upon an average yield of approximately 5½ centals (550 lbs.) per acre, it is estimated the produce of at least 4,000 acres of linseed are necessary to meet the State requirements. Pending the establishment of a crushing mill, it would be necessary to export our crop to the oil mills of the Eastern States. There is insufficient linseed grown in the Commonwealth to meet its requirements, for the importations of linseed for the year ending 30th June, 1930, amounted to 487,968 centals, valued at £459,247.

Though linseed can be grown on a variety of soils, the most suitable soils are well-drained chocolate loams or black soils rich in organic matter. A suitable climate and thorough preparation of the seed-bed are of more importance than the selection of a particular type of soil, unless the soil be poor and impoverished, in which case satisfactory results cannot be expected. Heavier soils usually give the best results. On sandy soils the fibre is usually short. Any soil capable of producing good crops of wheat, oats, barley or potatoes is suitable for the production of flax.

The thorough preparation of the seed-bed has a very important bearing upon the success of this crop. In preparing the soil for the flax plant, two things should be kept prominently in mind. These are:—

1. That weed growth seriously reduces the crop yield, and lessens the value of the straw for fibre production.
2. That the plant contains the fibre right throughout its length and, under Australian conditions, requires to be cut close to the surface of the ground.

The first of these requires that the treatment of the land should be such as will destroy weeds, and the second that the surface should be level and free from large lumps, so as to facilitate the harvesting of the straw with as little loss of length as possible; for, as the crop for fibre in Australia is harvested with the reaper and binder, the nearer the ground the binder knife can be set, the longer will the fibre be and therefore the heavier the yield, and because of its greater length, the better will be its quality.

In addition to being thorough, the preparation of the land should be deeper than is customary with wheat. The land should be fallowed in winter or spring and then worked down during the summer to a fine tilth. The methods adopted for the production of good crops of wheat or oats are suitable for the production of flax.

There are a number of varieties in existence, some of which have white blossoms and some blue. The variety which is generally used throughout Australia is a blue-flowering one known as "Blue Riga." It is likely that it is so called because the original seed come from the port of Riga, through which grain from the Baltic provinces is exported.

More recently a variety known as "J.W.S." has been introduced from Ireland and has given satisfactory results. This variety is the result of selection for long-stemmed fibre plants by Mr. J. W. Stewart, of Coleraine.* It is probably a selection of "Blue Riga."

In view of what has been done in connection with seed selection in America and elsewhere, it is probable that improved strains of this variety can be obtained and distinct varieties specially suitable for either grain or fibre isolated and fixed.

At the Chapman Experiment Farm small pure lines of several strains have been selected. It was also found that an unfixed strain from some of the imported varieties produced much longer fibre than the ordinary varieties in cultivation, and also combined this quality with earliness. Under our conditions this may prove of special value for fibre in the earlier and drier districts.

The best time to sow is in early autumn, during the month of April and the early part of May. For the dual purpose crop of grain and fibre, the seeding should be about 60 lbs. of seed per acre. For fibre only, the rate of seeding is increased and in some instances to as much as 100 lbs. per acre. For the production of grain only, the rate of seeding is 40 lbs. and sometimes as low as 20 lbs. per acre.

When the crop is intended for fibre, the seed is preferably sown broadcast, but may be sown with the ordinary wheat drill. If sown with the latter, the seed tubes can with advantage be removed from the hoe or disc shoes and the seed allowed to fall and spread on the surface of the ground. When this plan is adopted the seed can be covered by subsequent harrowing. The seed, if sown deeply, fails to germinate and should therefore always be sown near the surface.

Professor H. L. Bolley, of the North Dakota Experiment Station, found that the cause of soil becoming "flax-sick" was due to a disease called "Flax wilt." Though the disease will not attack wheat, its effect on flax is similar to the "Take-all" of wheat. It attacks flax plants in all stages of their growth, and when the soil is badly infected, the young plants are killed before they reach the surface of the ground. It has, however, far more endurance than wheat "Takeall," for "Flax wilt" once established in the soil requires five or six years for its eradication. The disease is generally introduced into the soil by means of infected seed. This can be prevented by sprinkling the seed with a solution of formalin at the rate of 1 lb. formalin to 40 gallons of water, which is sufficient to treat 55 centals of seed. Sufficient of the solution should be applied to evenly damp the surface of the seeds, after which they should be shovelled over once or twice and then covered with a sheet of bags or other material until dry enough to sow.

Treatment of all seed brought on to the farm is desirable, and as the presence of the disease has been reported in the Eastern States, and is known to exist in other parts of the world, the treatment of all imported seed to prevent flax wilt is essential.

* I. W. Seaton, B.Sc., Head of Plant Breeding Division, Ministry of Agriculture, Northern Ireland, in Balliere's Encyclopaedia of Scientific Agriculture, 1931.

Because of soils readily becoming "flax sick," flax has been regarded as an exhausting crop; but it has been shown to be no more so that other grain crops. It should, however, not be planted in the same ground in consecutive cropping years, but should be grown in rotation with other crops, and to prevent "flax sickness" now known to be due to the disease "Flax wilt"—all seed, and especially imported seed, should be treated with formalin.

As with the wheat and oat crop, superphosphate should be applied at time of seeding at the rate of about 1 to 1½ cwt. per acre. Experience indicates that the addition of about 25 per cent. of sulphate of ammonia to the superphosphate will be beneficial, and on sandy soils it is probable that potash manuring will also be required.

The crop, particularly that intended for fibre, must be kept free from strong-growing weeds like thistles, docks, wild radish, etc. These must be pulled out while the crop is short, for they not only reduce the yield but also give trouble in the after treatment of the straw for fibre. Even small low-growing weeds are objectionable if harvested with the straw, for they cause trouble in the subsequent treatment of fibre.

As the crop approaches maturity the stalks change from green to a golden yellow and the small leaves wither and drop off. The old method of pulling the crop for fibre by hand is only suitable for small areas and where labour is cheap and plentiful. It has been superseded in Australia by harvesting with the reaper and binder, and in parts of America with flax-pulling machines. If sufficient labour were available, it is probable that "pulling" would be the more profitable, for the plant contains fibre right down to the roots, and by pulling, greater weight, extra length, and a better quality fibre is obtained.

The following remarks by the Head of the Plant Breeding Station, Ministry of Agriculture, Northern Ireland, regarding methods of harvesting are of interest to prospective flax growers in Western Australia.*

"From time immemorial it has been the custom to pull flax up by the roots rather than to cut it as in the case of corn crops. In Northern Ireland, at least, the chief reason for this procedure may well lie in the fact that the flax crop is, as often as not, badly laid before harvest time, but other reasons are also advanced. It is said that flax tends to become sour and deteriorates about the point of severance when cut, and cutting would undoubtedly be wasteful of the fibre. Pulling, too, enables the crop to be freed of such weeds as infest it, and which, if cut with the crop, would impede all subsequent operations.

"The increasing mechanisation of farm processes has left the flax crop singularly untouched, but this is due to the failure of invention rather than to the lack of it. Many flax-pulling machines have been tried, but none has proved commercially successful in Northern Ireland. Pulling by machine is usually achieved either by the action of rotatory combs intended to engage the crop immediately below the seed bolls, or by a system of revolving endless belts between which the growing plants are nipped. Either system might work well in a standing crop, though the second method would appear to have the disadvantage of pulling weeds too, but neither can be said to be successful where a lodged crop is concerned. So interwoven does a laid flax crop become, and so completely does its lying lack uniformity of degree or direction, the hardiest inventor may well quail before the task of its disentanglement by machinery.

"In countries such as Canada, where standing crops are usual, and where fibre, used as tow, is not more important than the seed crop, the combination reaper and binder is used in harvesting.

* I. W. Seaton, Bailliere's Encyclopaedia of Scientific Agriculture.

"The determination of a crop's fitness for pulling requires some nicety of judgment. In Ireland flax commences to bloom about the end of June, and the blooming period lasts for about three weeks. With its gradual cessation, growth in length also ceases, and the plant's energy becomes concentrated in the development of the seed bolls. Commencing at the base, the stem colour changes from green to yellow, and the basal leaves begin to fall off. The silkiest, glossiest, and strongest fibre results from pulling at the beginning of the period of stem colour change, but most farmers prefer to err on the safer side of over-ripeness and wait until the leaves have begun to fall, and the seeds to acquire a brownish tint in the capsule. Where both fibre and seed are saved, as in Belgium and Holland, the flax must, of necessity, be allowed to reach this stage of ripeness, but even in Ireland, where fibre is the only desideratum, it is estimated that for each farmer who pulls his flax too soon, five hundred pull theirs too late to secure the finest quality of fibre. A slight increase in yield is, however, gained by later harvesting. The crop is pulled by hand and tied in round sheaves or 'beets' of uniform size, the root ends being kept together.

"Uniformity in the size of 'beet' (sheaf) is important in the later processes. The value of the crop is enhanced by keeping separate flax of different lengths, since otherwise the shorter straws tend to fall from the bundles into the tow during the subsequent operation of scrutching, but such care in harvesting is seldom practicable.

"'Beets' (sheaves) should weigh from 7 to 10 lbs. each, and five pullers of average ability will harvest a statute acre per day. The beets are assembled in twelve-beet stooks, of which there should be eighty or ninety per acre.

"When it is intended to save seed from fibre flaxes, harvesting is usually slightly delayed. Any small depreciation in value of the fibre thus involved is more than compensated by the value of the seed when the undertaking is attempted in suitable climatic conditions which do not entail too much extra handling of the crop in the process."

Cutting with the reaper and binder is the only method at present available for Australian conditions. For reasons already stated, the crop should be cut as close to the ground as is possible, and for this plain knives are preferable to the serrated ones. The machine must be in good order, as the crop is much tougher to cut than the cereals. The sheaves should be small, as this facilitates thrashing, and should be placed in long double stooks rather than in round ones. As soon as thoroughly dry the sheaves should be stacked like wheat or oats.

Experienced growers in Victoria consider that 10 a.m. is quite early enough to commence cutting flax on any day; and that it should be cut only in clear weather, when it cuts the more easily. Loose straw is not desired at the flax mill, and therefore the sheaves should be tied securely. The band should be placed nearer the head than the butt, as the tendency is for the twine to slip towards the butt.

When a flax mill is available, the thrashing is invariably done at such by passing the bundles through rollers which revolve in opposite directions. When the straw is intended for fibre the thrashing should be done carefully, so as not to injure the fibre or disarrange the sheaves. If a crop which is intended for grain only has been harvested with a reaper and binder, the sheaves can be thrashed with an ordinary thrashing plant, or small lots with a flail.

Linseed does not shell readily, so that a crop required for grain can be left standing without risk of loss until all the seed bolls are ripe. It can then be harvested with a stripper-harvester. If the latter implement is used it may be desirable with some types to shut off portion of the blast by a canvas or other screen, otherwise the grain will be blown away.

The firm of H. V. McKay Massey Harris Pty., Ltd., has used its machines for harvesting thousands of acres of linseed both in America and New Zealand. Field engineers are watching the harvest in Australia closely this year and will collect very interesting information on the subject; but for those who wish to harvest their crop this year they have supplied the following information:—

"Three riddles altogether are used at the one time in the header: the standard 5 8in. riddle is used in the top of the riddle box, being fitted in the second rack in front, and the fifth hole from the top at the back; the 9 32in. lip riddle is used as the second riddle, in the fourth hole from the bottom at the back and the fifth rack in the front; and the 3 32in. x 1in. slot punched riddle in the second hole at the back and the third rack in the front. Both lip riddles are to be fixed with the lips down and facing the blast. It will be necessary to purchase the 9 32in and the 3 32in x 1in. riddles, and the cost of those is 25s. each. The setting of these riddles is, of course, only approximate, and will have to be altered slightly for varying conditions.

"It is suggested that the linseed be harvested only in hot weather, as this will make the stripping of the seed a simpler matter. If this is done we do not anticipate trouble with any other portion of the machine, but it is necessary to watch carefully that there are no holes or crevices through which the seed can flow, as linseed, being very slippery, will leak out rapidly through any crevices of this description."

For commercial purposes the straw is required to be an average length of about 30 inches. Unless the conditions are suitable for producing straw of this length, they cannot be considered satisfactory for the production of commercial flax fibre. The plant is measured from the butt where cut off with the reaper and binder (*i.e.*, to about 2 inches above the ground) to the top and including the seed branches. Shorter lengths of straw can be converted into excellent fibre, but the quantity of straw to be treated to produce one ton of fibre may be so much greater as to make the cost of treatment unprofitable. This is especially so as resultant fibre, being shorter, is not likely to be as valuable commercially as the longer fibre which would be obtained from the longer straw.

At one time in America the farmer grew the flax and prepared the fibre, and this was woven into linen by his wife. At the present time the farmer's work is considered to be completed when he has grown the crop and possibly thrashed the seed out of it. The preparation of the fibre is now carried out at a flax mill. Here the flax straw has to pass through several processes, viz., "retting," "breaking," and "scutching" before commercial fibre is obtained.

"Retting," or rotting, is a process of decay or fermentation by which the inner or woody portion of the plant is separated from the fibre. There are two ways of doing this, viz., "Dew retting" and "water" or "bog" retting.

The latter is the method most generally adopted in European countries; it is quicker than dew retting. This method consists of immersing the bundles in pits, pools or streams of soft water for about 7 to 14 days, the time depending upon the softness of the water and the temperature of the weather.

Writing on the subject of retting, I. W. Seaton* states:—

"The 'retting' or, literally, rotting of flax straw is a process of fermentation to which the straw is subjected as a preliminary to the extraction of fibre. Decomposition is allowed to continue until the fibre strands have been exposed by the disappearance of the outer cortical layers, and freed from the central pith by the dissolution of the pectinous substances which normally bind the two together. The pith itself is rendered more easily frangible in the process.

* Bailliere's Encyclopaedia of Scientific Agriculture.

"Fermentation is due to the activities of bacteria present in the plant itself. Both aerobic and anaerobic forms are concerned, the former beginning the process of decomposition and the latter continuing it. The initiation, maintenance, and speed of the action depend upon the suitability of various external conditions which affect the rate of propagation of the micro-organisms. The propagation of the bacteria is accelerated or retarded according to the temperature, chemical composition and acidity or alkalinity of the growth medium, in this case, water.

"Retting is variously carried out in ponds or tanks in which the water may or may not be slowly changed during the process, in sluggish streams or rivers, or by spreading the flax on the grass to allow of its saturation by dew, rain, or other form of precipitation.

"Pond retting in specially constructed ponds about 10 feet wide and 4 feet deep is the usual Irish method. The 'beets' (sheaves) of undeseeded flax are placed roots downward in these ponds. They are packed loosely, and set in an inclined position in overlapping layers. The whole mass of flax is then weighted down by stones or sods placed on heavy planks. A pond 36 feet long usually suffices for the crop from an acre. The water used should be soft, clean, clear and free from mineral salts which may stain the fibre. The walls of the dam possess similar staining properties, though not to any harmful extent. Blue clay tints the fibre bluish, while a yellow clay imparts a pale-yellow colour.

"With the commencement of retting the mass of flax tends to rise, and as the process nears completion it sinks. The system of weights is usually adjusted in such a way as to maintain the flax at a constant level, 2 or 3 inches, below the surface of the water. The process is complete when the stems break readily without bending, and when the fibre parts readily and completely from the pith. This, in favourable conditions and with a water temperature over 60deg. F., usually occupies eight to twelve days. Under-retting renders the subsequent mechanical processes in the production of flax more difficult, while over-retting, by the dissolution of the fibre strands themselves, will destroy their value completely.

"The process is retarded if the water of the pond is slowly changed during retting, and this variation in practice is believed to produce a better quality of fibre. Retting is much slower in new ponds than in old ones, as the organisms responsible accumulate in old ponds and survive as resting spores in the black mud which gathers on the pond bottoms. This deposit is often used as an infective material to accelerate the action of new dams. Dams are usually filled a few weeks before steeping time.

"Retting in slowly moving rivers is most successfully carried out in the River Lys, Belgium. The water of the Lys is very deep and sluggish—the flow being about three-quarters of a mile per hour. The water is soft and contains a large amount of organic matter from the towns and villages on its banks, which, together with the enormous amount of retting carried on, ensures a continuous supply of putrefactive organisms sufficient to compensate for the quantity carried downstream by the river's motion.

"Steeping extends from mid-April to mid-October, and is by no means confined to flax grown in the immediate neighbourhood. The flax beets (sheaves) are arranged, heads and roots alternately, in large wooden crates which are shrouded in coarse canvas to retard water movement through the flax. These crates are submerged 3 or 4 inches below the water surface by weights, and are moored to the river bank. Retting occupies from six to nine days according to the temperature and condition of the water.

"The water temperature in both pond and river retting varies from about 54deg. to 77deg. F., and, within limits, the rate of the process varies directly with increased temperature. This fact has led to the development of many systems of tank retting by which the water temperature and other contributory conditions can be controlled. Moreover, retting can be practised in this way in centrally situated localities and all the year round. The process was first promulgated by Schenk in America in 1846. The water temperatures used vary from 70deg. to 90deg. F., and retting may occupy as little as fifty hours, but the process is usually a costly one and the fibre produced is apt to give an inferior yarn."

Experimentally flax has been completely retted at the Washington Experiment Station, U.S.A., in 110 hours by maintaining the temperature of the water at 110deg. Fahr.

In the "Country Gentleman" of April, 1930, A. Cutting refers to the installation of flax retting tanks by the Oregon State Government wherein flax is treated commercially in slowly circulating warm water, not exceeding 84deg. Fahr. Under this new method the time of retting is reduced to four or five days, whereas formerly with cold water in tanks it took thirteen to fifteen days. In the same article he also refers to the very great success which has attended the introduction of mechanical handling plant which has reduced the cost of fibre production by two-thirds, in connection with which, flax pulling machines are of particular interest. With regard to these it is stated—"With this machine the flax is pulled up by the roots and carried upright into a binder head by three sets of inclined belts running in contact. There it is bound into eight-inch sheaves with the root ends all square across the butts. Not only does it harvest the crop cleaner than by hand, but it actually takes the place of some fifty men."

It is believed that dew retting was introduced into Australia about 1891 by Messrs. Woolf Bros., of Traralgon, Gippsland, Victoria, who are also the pioneers of the Australian flax industry.

The work of dew retting in Victoria, as described by Messrs. Woolf, consists of spreading the flax straw in straight rows about an inch thick on a clean paddock, grass for preference, but stubble will do. The flax being spread out in this way is allowed to lie for two to four weeks on one side, when the rows, by a deft process of running smooth sticks like fork handles under them, are turned over and allowed to lie for about the same time on the other side. The straw is allowed to remain exposed to the weather until the "retting" is completed. As with water retting this depends upon the temperature and also upon the weather experienced. The proper stage is reached when the inner woody stem breaks square off on being bent, and the fibre separates easily from the stalks. As retting is a process of decay which, if carried too far, will injure the quality of the fibre, it is important that the process should be stopped when the proper stages has been reached. This can only be determined by observation, and requires a skilled and experienced worker. The risk of injury is much less with dew retting than with water retting.

When the straw is sufficiently retted, it is dried and then stored for further treatment or dealt with immediately by machines known as "breakers" and "scrutchers." These effect the removal of the woody useless matter from the fibre. After the breaking and scutching, the cleaned and dressed fibre is packed in bales for market. The produce from the scutcher and breaker consists of clean fibre, fine tow and coarse tow.

In America binder twine is made from flax straw, and for this purpose it is not retted but treated by a drying process which enables the straw to be converted into binder twine by one continuous factory process.

A good crop in Australia produces about 2 tons of unthrashed straw per acre, and from this will be obtained about 6½ centals of grain and 34 cwt. of thrashed straw. Average yields are about 30 cwt. of unthrashed straw containing about 5 centals of linseed grain and about 25 cwt. of thrashed straw.

The flax miller purchases the unthrashed straw from the grower. Prior to the war the price paid was £3 10s. per ton, and during the war £4 per ton. The following table* shows the produce and its prewar value obtained from one ton of unthrashed flax straw in the Drouin district, Victoria:—

Produce.	Pre-War Prices.	£ s. d.
3 cwt. Linseed	At £14 per ton ...	2 2 0
1½ cwt. Fibre	,, £45 ,, ,, ...	2 16 3
½ cwt. Fine Tow	,, £10 ,, ,, ...	0 5 0
22 cwt. Coarse Tow ...	,, £5 ,, ,, ...	0 10 0
		£5 13 3

The yield of clean fibre given in the above table is considered by a competent authority to be a very low one and capable of considerable improvement.

In March last, Meggitt Ltd., the Australian manufacturers of linseed oil and cake (linseed nuts) were offering £12 per ton (10s. 8d. per cental) for Australian grown linseed grain, and also pointed out that normally the price of best quality Calcutta grain is £18 per ton, c.i.f. Sydney.

In Canada and the United States of America the crop is grown largely for grain alone, and there is no reason why at least sufficient for the requirements of Western Australia cannot be grown in this State; but to derive the fullest benefit from the growth of this crop the straw as well as the grain should be utilised for fibre.

When the area of linseed grown in this State warrants it, it is believed that facilities for crushing the grain and extracting the oil will be forthcoming and thus render the State independent of importations of linseed oil for paint or linseed cake for stock feeding. It is also possible that facilities for treating the fibre will also become available. This is particularly the case, as it is reported that machines have been devised for treating the straw and manufacturing the fibre without the preliminary "wet" or "dew" retting.

The advantages to the State arising out of the establishment of the flax industry and the prospects of remunerative returns to individual farmers are sufficiently good to warrant them planting small areas to ascertain the suitability of their particular holdings for the growth of this crop. No exceptional methods of cultivation are necessary; the thorough methods practised by careful growers to produce good crops of potatoes, oats, or wheat are sufficient.

* Agricultural Research in Australia: Bulletin No. 2, Advisory Council of Science and Industry.

EXPERIMENT ON GREEN MANURES.

H. R. Powell, B.Sc. (Agric.),
Agricultural Adviser.

During recent years more and more attention is being paid to the subject of green manures. In years past the ploughed-in residues of weeds assisted considerably in improving the physical and organic nature of the soil, but now we have definite proof that some plants (*e.g.* Leguminoseae) are better adapted for the purpose. These legumes, which include the peas, beans, vetches and lupins, have formed definite partnerships with bacteria in the soil, by which the bacteria have free accommodation in the nodules on the roots, a plentitude of water and plant food, and the only thing required of them is that they supply the legume with nitrogen. This they are able to do from supplies obtained directly from the air. Thus we see that the nitrogen derived from the decomposition of a leguminous green manure crop, is in the nature of a direct gain to the soil.

The following is a table showing the nitrogen content of various legumes:—

	Nitrogen in 10,000lbs. green crop.	Equivalent to Nitrogen in Amm. Sulphate.
	lbs.	lbs.
Tick Beans ...	58·0 ...	547
Vetches	61·0 ...	575
Peas	51·0 ...	481

The above does not necessarily mean that all the nitrogen contained in the above crops will be available to the following crop, but it signifies that given proper treatment, attention being paid to ploughing in at the right time (when ample supplies of moisture are available), the chances of its loss will be minimised.

The green manure crop does not only supply a limiting factor to plant growth, namely nitrogen, but it supplies other virtues as well. Included in them are the following:—

(1) The formation of nitrogen to the available nitrate form calls for the services of specific soil bacteria. It is obvious, then, that a copious supply of organic matter is desirable for their growth and multiplication to ensure that in succeeding years the work of nitrate formation will be earlier and better completed before the drying out of the soil inhibits their action.

(2) The physical nature of the soil can also be greatly improved. Light sands can be built up into good soils by humus incorporation. This has been

actually done in Germany on barren lands by the use of green manure lupin crops. Heavy lands in conjunction with liming can also be greatly improved.

As a few of the virtues of green manuring have been discussed, I will now relate the progress of an actual experiment carried out in the vineyard of Mr. H. Thomas at Caversham. The objects of the experiment were as follow:—

I. To determine the green manure crop that best suited the soil and climatic conditions of the Caversham and similar grape-growing districts.

II. To determine the ease with which the crop could be successfully ploughed under at the right stage.

III. To determine the quickness and completeness with which the crop decomposed when ploughed under.

Regarding I.—Naturally, varieties of legumes suggested themselves first of all. We saw before that they had the power of really adding to the soil's supply of nitrogen. They are fairly quick growing, and their herbage is succulent. It was then decided to test the following legumes—

(a) Field Peas.
(b) Vetches.
(c) Tick Beans.
(d) Peas and Beans.
(e) W.A. Blue Lupins.
(f) N.Z. Blue Lupins.
(g) N.Z. White Lupins.

In addition to the crops of legumes it was thought that some of the cereals might have qualities other than that of the addition of free nitrogen. Of course, there are bacteria in the soil living on organic matter that can fix nitrogen themselves, and thus add to the soil's supply. The organic matter supplied by the cereals might suit them better; therefore, it was decided to try out—

(i.) Barley,
(ii.) Oats,

singly, and also to include them with some of the legumes, namely, oats with peas, barley with peas, and oats with vetches.

The arrangement of the plots and the quantities of seed sown per acre will be seen from the following table. The individual plots, consisting of alternate rows of currants, ran east and west and were .066 of an acre in extent. The soil was even and consisted of an alluvial silt, of fairly good quality. The slope was even, and ran east and west, and the drainage waters were encouraged to escape by the fact that the ploughing was turned on to the vines. Consequently it was found that little damage was done by standing water.

The seed was sown on the 22nd May, 1931, in seed beds that were well ploughed and in a good state of tilth. Prior to seeding, superphosphate at the rate of $3\frac{3}{4}$ cwts. per acre had been applied.

The following table traces the history of the plots from germination to incorporation within the soil:—

GREEN MANURING EXPERIMENT, 1931.

STATEMENT No. 1.

Green Manure Crop.	Seeding Rate per acre.	Planted.	Germinated.	Ploughed in.	Stage of Growth.	Weight Plots.	Weight per acre.	Mean of Controls.	Gain or Loss.	Remarks.
	bushels.					tons.	tons cwt.		cwt.	The rows were E. and W. In every case the S. sides were more advanced.
Field Peas, Control	2	22-5-31	4-6-31	14-9-31	Formation first pods	825	12 9·98	...	8·4	This crop came away well from the start. The E. end was slightly affected by water. This lowered the yield slightly. Lucerne Flea was fairly abundant, also slugs.
Peas and Tick-Beans	1 of each ...	...	6-6-31	...	do. flowering ...	8,091	12 5·18	...	cwt. 13·2	The two crops came away well and presented a fine appearance. The beans supporting the peas. There were less Lucerne Flea and slugs, and work of ploughing was rendered easy on account of the beans firm hold.
Tick Beans	2	...	6-6-31	...	Flowering	7,880	11 9·18	ton cwt. 12 15·98	cwt. - 19·2	This crop also promised well from the start. Beans were 4½ to 5½ ft. in height, succulent, and their firm hold enabled them to be ploughed in easily despite their height and bulk.
Vetches	1½	...	2-6-31	14-9-31	Flowers not apparent	7,616	11 10·78	...	ton. cwt. 7·6	Germination and growth were excellent. The plants 2½ft., much branched, formed a dense carpet-like growth. Ploughed under with ease. These plants have a very firm hold. There were less Lucerne Flea and slugs, and a noticeable feature was the dense mass of fleshy roots in the ground.
Field Peas, Control	2	...	4-6-31	...	First Pods	8,804	13 6·78	...	+ cwt. 8·4	Similar to the first control, but growth was more even. These plants have a fragile hold in the ground. This made ploughing in extremely difficult. Unfortunately discing was impossible. The coulter on the Oliver Plow was ineffectual.
Vetches and Oats ...	¾ and 2½ ...	...	2-6-31 1-6-31	...	Flowers not apparent	*The following plots were not weighed.* Vetches made good growth except at the W. end, where the soil was so somewhat shallow and suffered through excess water. The oats were not up to expectations although they did better here than by themselves. Since the 31-8-31 they improved greatly, and may yet have yielded well but then would have been useless for a green manure crop.				

W.A. Blue Lupin ...	30lbs.	22 5 31	10–6 31 Max. 24–6–31	14–9–31	Flowers just showing	This plot was a failure. Germination was erratic and prolonged ; growth was poor. Nodule formation was apparent. They commenced to show some improvement from the 31–8 31 where somewhat higher temperatures were recorded. The bacterial nodules were concentrated on at the tap root, a fraction of an inch below the base of the stem.
N.Z. White Lupin ...	50lbs.	...	1 6–31 Max. 24–6–31	...	Minimum flowering	Germination promised well. It was fairly even. Growth however, remained stationery till the 31–8–31. On the 14–9–31 there was a great improvement, but the greater was between the 14–9–31 and the 18–9–31. Unfortunately the stunted N. side mitigated against their being weighed. The bacterial nodules were all situated on the lateral roots, somewhat the size of a pea. Rows running N. and S. may give more favourable results.
N.Z. Blue Lupin ...	50lbs.	...	do.	...	do.	Germination was fairly good. They showed the same responses to late growth as did the white lupins. Their foliage is, however, more scanty and thicker sowings would have to be resorted to. Their bacterial nodules are borne at the base of the stem and a few small nodules on the lateral roots, which were not so freely produced as the white lupins.
Field Peas, Control	2	...	4–6–31	...	First Pods	Growth here was parallel to the other controls.
Peas and Oats ...	1½ and 4 ...	...	4–6–31 1–6–31	... ...	do. ... ... Flowers not apparent	Peas were excellent, but the oats, as with the vetches, failed to respond, although they were better than the oats by themselves.
Peas and Barley ...	1½ and 3 ...	...	do.	...	First Pods—In ear	The barley in this plot apparently suffered more through lack of warmth. The plants were stunted and remained yellow in colour even on the 18–9–31 when they were in ear.
Oats	4	...	1 6 31	...	Ears not apparent	Till the 31 8 31 this plot was yellow in colour and stunted in growth. From that date to the 18–9 31 the plants improved greatly in size and colour, but did not warrant weighing.
Barley	3	...	do.	...	In ear	This plot remained yellow and stunted. Indications of earing occurred on the 31–8–31.
Field Peas, Control	2	22–5–31	4–6–31	14–9–31	First Pods	This plot was as uniform as the other controls.

Unfortunately, as seen from the statement, the cereals and lupins failed to come up to expectations. Judging by various crops in the vicinity I came to the conclusion that the particularly cold and cheerless weather was in the main to blame. It is interesting to note that the shelter afforded by the cover crop somewhat improved their growth and condition.

With regard to the lupins, the cold weather was again instrumental in checking their growth, together with an insufficiency of the specific nodule bacteria in the early stages of their growth.

On the 14th September, with the advent of a little warmth, the plants, especially the New Zealand varieties of lupins, immediately responded, and had it been possible to record the time of ploughing, indications pointed to the fact that a considerable amount of material would have been returned to the soil. However, it was too late.

The failure of these crops emphasises the fact that a green manure crop must not be too susceptible to variations in the climatic conditions. In other words, it must be reliable.

The following is an analysis (taken from "Feeds and Feeding" by Henry & Morrison) of the following crops—

	Per cent. dry matter.	Amount in 1000 lbs. green material of		
		Nitrogen.	Phosphoric Acid.	Potash. Potash.
Tick Beans	17·6	58	12	37
Peas	18·8	51	12	32
Vetches	20·4	61	16	50

Applying these analyses to the results obtained, we have—

Crop.	Weight per acre.	Dry matter.	Nitrogen.	Equivalent to Nitrogen in Ammonia Sulphate.	Phosphoric acid.	Equivalent to phosphoric acid in Super.	Potash.	Equivalent to Potash in Sulphate of Potash.
	tn. cr.	cwts.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Tick Beans...	12 0	42	156	735	32	286	99	185
Peas... ...	12 16	48	146	688	34	304	92	170
Vetches ...	11 11	47	157	740	41	366	128	237

It is significant to note that very little difference of variety of crop does not determine the composition of the nitrogenous and mineral material contained in the crop.

Vetches returned more material to the soil than did either the pea or bean plots, yet they returned less total green bulk.

I previously emphasised the fact that the nitrogen obtained from the leguminous green manure crop is more or less in the nature of a complete gain to the soil. The organic nitrogen in the crop is obtained from the nodule bacteria and built up into plant tissues. On the decay of these tissues the organic nitrogen is converted by the specific action of certain other bacteria to the nitrate form of nitrogen which usually exists in the form of a calcium nitrate. The organic material incorporated also stimulates the growth of other bacteria, some of which have the power of directly fixing nitrogen from the air. On the death of their bodies nitrates are eventually produced.

Turning our attention now to the minerals obtained in the crop, it is obvious that they were obtained from the soil and that they are going back into the soil. The roots of these crops have ramified through considerable areas of soil, collecting phosphoric acid and potash, etc., and other substances in solution from far and wide. These substances are especially concentrated in the growing and fleshy portions of the plants. Now, it seems most probable that these minerals, when set free by decomposition, are in an ideal place, for the feeding roots of the vine are essentially shallow.

II.—*The ease of ploughing under.*

The ease of ploughing under a green manure crop carries an instant appeal to all engaged in viticultural pursuits, and justly so. An easy burial, especially when well done, saves time and money, and consequently is one of the factors that contribute to ultimate success or failure.

When we consider the ease of ploughing under the various crops we see that some are much easier to manipulate than others. For example—

Field Peas were extremely difficult to plough in. In that case I think the principal cause was the fact that the peas had a very insecure hold in the soil which resulted, on ploughing, that accumulations of material choked the plough, caused incomplete burial, and incidentally tried the patience of the operator. Therefore, we must bear in mind that material incompletely buried only partially decomposes, and the purpose for which the crop was planted is, therefore, not consummated.

Tick Beans were fairly easy to plough in, and only small amounts of material protruded from the central furrows. I have seen that when, prior to ploughing, the beans are knocked down by the reversed harrows, the actual work of ploughing has been rendered more easy, and that also the incorporation of the crop has been better done.

Beans and Peas.—These two legumes grew well together. The beans easily supported the peas, and thus made the work of ploughing under fairly easy, and resulted in a more efficient burial of the crop.

Vetches.—This crop was particularly easy to plough under. This was due to the particularly firm hold that the vetches had in the soil.

From the above observations it will be seen that the ease of ploughing under of the various crops is as follows:—

(a) Vetches.
(b) Tick Beans.
(c) Beans and Peas.
(d) Peas.

III.—*Decomposition.*

The plots were ploughed on the 14th of September to a depth of 9 inches. From the beginning of September to the incorporation of the green manure crops 85 points of rain fell. The ground was still moist and had not dried out through the transpiration of the crops. From the 14th of September to the 2nd October 115 points were recorded, and from the 2nd October to the 5th November 138 points of rain fell. On all these dates samples were taken, and the processes of decomposition studied.

Field Peas.—On the 2nd October, 1931, I found that the lack of uniformity in ploughing made it somewhat difficult to obtain even samples; however, decomposition had proceeded rapidly: the leaves, tendrils and the extreme upper stems had completely lost their form, and consisted of green slimy masses of material. The lower lignified stems were entirely unaffected, while the major parts of the upper stems were reduced to vascular skeletons. The few pods were unaffected.

Where the plants had been buried completely, their large moisture content 81.2 per cent., had considerably increased the processes of decay but those incompletely buried had dried out only. On the 17th October I was surprised to see no noticeable advancement in decomposition. The ground was obviously moist, but one did not see the waxy masses that were to the fore last visit. The concentration of water had been lowered, thus checking decay. In some of the plants fungi with extensive framework could be made out—only the more resistant tissues had been touched.

On the 5th November no further advancement was to be seen.

Vetches.—On first sampling on the 2nd October 1931, this crop seemed to have lost more bulk than the others. The decay of the parenchymatous tissues was very active, and as liquification had not proceeded to such an extent, due to the fact that the crop was in a less advanced state of maturity, decomposition was more general. On subsequent visits no further progress was noticed, barring the vascular framework of the plants in the majority of cases quite intact. The residues were, however, extremely light.

Tick Beans.—On the 2nd October, 1931, decomposition was very active in the succulent parts of the plants, but these were restricted to the leaves and extreme apical portions of the stems. The larger parts of the stems, though not liquified to any great extent, were entirely unaffected and were plainly to be seen in the pits they were ploughed in. The rate of decay appeared to be directly correlated to the concentration of water contained in the plant tissues.

On the 15th October, 1931, it was found that decomposition had commenced on the stems. These were blackened, but the decay was only superficial and had apparently ceased before my visit. In some cases the decomposition of the parenchymatous tissues had not been completed, though the soil conditions were excellent, and compared more than favourably with well prepared fallows found in many parts of the district.

On the 5th November, decomposition was found to be no further advanced and it was obvious that incorporated in the soil was a large amount of woody material.

To further compare the rate of decomposition of the various crops two areas of six square yards were dug up in each plot and the material sifted out and weighed. This was done in the vetch and bean crops, but, unfortunately, due to incomplete burial it was impossible to do this with the oat crop.

VETCHES.

	lbs.
Average weight two weighings of dried decomposed material	2·25
Average weight two weighings of green crop	33·625
Average calculated to dry weights	6·75
Approximate loss of weight through decomposition	4·5
Percentage loss	67%

TICK BEANS.

	lbs.
Average weight, two weighings of dried decomposed material ...	4
Average weight, two weighings, of green crop	34·37
Average calculated to dry weights	6·06
Approximate loss of weight through decomposition	2·06
Percentage loss	34%

These figures cannot be taken as scientifically correct, but, nevertheless, they approximate closely to observations made in the field.

The residual material of the bean crop was considerable. It not only included the liquified lower stems, but, in addition, the extreme basal portions of the plants and the adherent roots, which were not included in the initial weighting for the green crop bulk. On the other hand, the vetch residues, with a minimum of liquification, were light, showing that decomposition was more complete.

Though this experiment was not as comprehensive as it might have been, it demonstrated, however:—

(a) That certain crops are not suitable for general use as green manures for the conditions under which they were tested. It is necessary to have in mind the fact that the green manure crop must be dependable for all conditions: therefore, we can safely assume that barley, oats and the lupins are not satisfactory for the purpose.

(b) That peas, tick beans and vetches made excellent growth.

(c) That tick beans and vetches could be easily and completely incorporated in the soil, while the heavy crops of peas could not be readily buried. The peas, therefore, are an uneconomic loss through not serving the purposes for which they were used. Discing prior to ploughing would ensure a better burial of the green material, but on the smaller farms this would be impossible owing to lack of proper implements.

(d) That vetches decomposed much more readily than did either the beans or peas, and from the analyses they contained more nitrogen, phosphoric acid and potash than did the other crops. The question of the maturity of the crop when ploughed in, is very important—from the chart it will be seen that the vetches had not commenced to flower, that the beans had, and the latter is the stage that is usually recognised as the best time to plough in.

I am convinced that the deciding factor in complete and economic decomposition is the presence of a high percentage of parenchymatous tissues in the crop, together with a high percentage of moisture. This stage has already passed when the crop is flowering.

The nitrogenous, phosphoric and potassic material are especially concentrated in the rapidly growing tissues, and it follows that a rapid decay will ensure that these materials will be readily available for the vine or tree as the case may be. It is hoped that experiments will be conducted next year to confirm these statements. Other factors affecting green manure crops are the following:—

(1) The retarded ploughing in of a crop may, especially if succeeded by dry conditions, seriously injure the vines, through—

  (a) excessive drying out of the soil by the green manure crop through transpiration;

  (b) failure of the crop to adequately decompose, thus causing further drying out of the soil;

  (c) loss of plant requirements contained in the lignified and undecomposed residues;

  (d) waste of time and money if the green manure crop does not serve the purpose for which it was intended.

(2) Green manuring is recognised by the leading Agricultural countries of the world as a fundamental for the successful growth of horticultural and viticultural crops. It also enables the phosphoric and potassic fertilisers to be applied in the autumn, when the green manure crop is sown, thus improving that crop, and permitting the major crop to benefit more fully from the fertilisers than when they are applied in the spring.

In conclusion, I would like to thank Messrs. Wilson & Johns and Mr. William Padbury for their generosity in supplying seed; Mr. Thomas for the use of his vineyard for the experiment and for his sustained interest, and the Members of the Midland Junction Horticultural Classes for their co-operation.

CREAM CHEESE.

G. K. Baron-Hay, Superintendent of Dairying.

During the last few weeks a large number of inquiries have been received from farmers as to a method of making cheese on the dairy farm for home consumption.

The manufacture of Cheddar cheese is a highly technical process, and requires special machinery and experience in operation.

Cream cheese, however, calls for very little special apparatus, and, with care, a highly palatable and nutritious article may be produced on any dairy farm.

The following articles are required:—

One 2-gallon enamel bucket.
2 smaller buckets for straining.
A supply of fine dairy salt.
Rennet, either tablets or liquid,
Ladle,
4 huckaback straining cloths, 2 feet square,
A dairy thermometer,
Several cheese moulds—any empty tins of a suitable size may be used.
A supply of cheese cloth for lining moulds.

For the production of cheese it is essential that cleanliness should be observed in the handling of milk during milking, separation, and in all processes mentioned for the manufacture of the cheese. Milking utensils must be clean and sterile, every utensil with which the milk or cream comes into contact being properly washed in boiling water before using same.

The cream selected for cheese-making should be fresh, and should have a butter fat content of approximately 15 per cent. As the use of the farm separator is general in this State, and a butter fat content of 40 per cent. is the aim in separation, it will be necessary to break down the butter fat content of such cream before treatment for the making of cream cheese. Fresh skim milk may be used for breaking down the cream, for which, however, a simple calculation is required for the quantity of skim milk to add to the cream in order to obtain the desired result of 15 per cent. butter fat in the final product. The square method below will be found the most convenient.

This method gives the proportions in which the cream is separated, and skim milk should be mixed in order to produce a product containing 15 per cent. butter fat.

A suitable quantity of cream with which to work is two gallons, or about 20 lbs., which will make approximately 7¼ lbs. cream cheese.

After the cream testing 15 per cent. butter fat has been produced, this should be brought to a temperature of approximately 80deg. Fah. It will be found that if separation is carried out soon after milking, the temperature will approximate this figure. When at this temperature, for about 20 lbs. cream a starter of ½ cup of sour cream, having a pleasant flavour, should be added and well stirred. Then

the cream should be allowed to stand for several hours until a distinctly acid flavour may be detected, but no curdling has taken place. The acidity will then be from .18 to .22 per cent.

In Western Australia, particularly during the summer months, the addition of a starter is unnecessary, as on keeping cream for from 12 to 24 hours, depending on the atmospheric temperature, an acidity of the figure mentioned will be developed naturally, and, if cleanliness has been observed in the production of the cream, this acidity should be of a desirable character.

Rennet, to coagulate the casein, is now added, 2 gallons of cream requiring 40 drops of rennet, which should be mixed in a small wineglass of clean water and poured slowly into the cream, stirring well while adding to ensure thorough mixing. This should be done in a perfectly clean enamel bucket. The cream is now allowed to stand for from 1½ to 2 hours until the curd is firm. Firmness may be tested by drawing the finger or a glass rod through the curd which should break cleanly without any dragging. When this stage is reached the cream is ready for straining. The curd should now be removed from the whey or liquid portion with a skimmer or ladle, and laid gently on straining cloths which should line one or more buckets in readiness for straining. Huckaback towelling, about 2 feet square, has been found a suitable material to use as strainers. The straining cloth is now tied around the curd, which should be hung for 24 hours to allow the moisture to escape. When the mass is fairly well drained the cloth should be changed, fine salt added to the curd, then rewrapped and put under slight pressure for a few hours. The percentage of salt to add depends on the taste of the manufacturer, 1½ per cent. being found most popular, or 27 ounces for the amount of cream being used, *i.e.*, 20 lbs. producing approximately 7¼ lbs. cream cheese.

The degree of pressure and the length of time to be kept under this pressure will be indicated by the condition of the curd. A soft curd which would have been developed where the acidity was low would need approximately 8 lbs. pressure for 8 hours, while a fairly dry firm curd produced where the acidity was high might require only 4 lbs. for 4 hours. A brick weighs approximately 4 lbs., and may be used for weighting, being placed over a piece of wood, beneath which is the cheese securely wrapped in the huckaback towelling used for straining. Pressure should be removed when the curd is sufficiently dry, and the curd moulded into some suitable form. Shallow cylinders, from 1½ to 2 inches deep and 3 inches across, which will contain 7 to 8 ounces of cheese, will be found suitable. These moulds should be lined with cheese cloth before the cheese is pressed into them, which assists in lending firmness to the resulting cheese.

Cream cheese made by this method is extremely palatable, but will not keep for long periods, and should be used within a few days of being manufactured.

DENTITION OF SHEEP.

H. McCallum, Sheep and Wool Inspector.

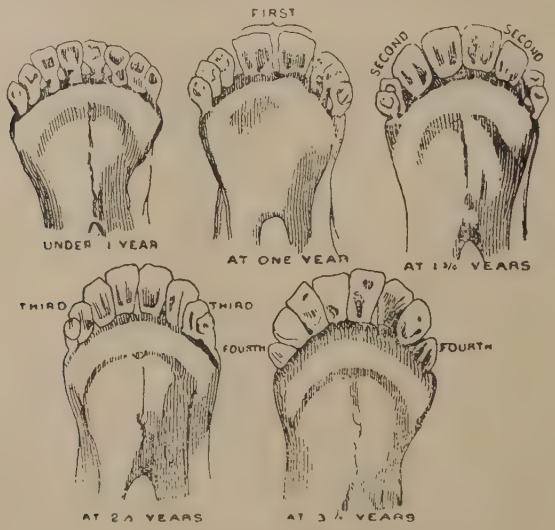
A most important matter in connection with sheep farming is that of judging the age of the animals. This is usually estimated from the condition of the eight incisor teeth in the front of the bottom jaw. However, misunderstanding sometimes arises when the exact age of the animal is required, and the better method when offering sheep for sale is to state the date of dropping. This information is not always available, and the following description of the sheep's mouth from birth to maturity will be useful to those whose knowledge of sheep is slight.

A full-mouthed sheep has thirty-two teeth, eight incisors, and twenty-four molars, six on each side of both jaws. The incisors are for nipping off the food and the molar teeth are used for mastication, their surfaces being irregular and suitable for grinding.

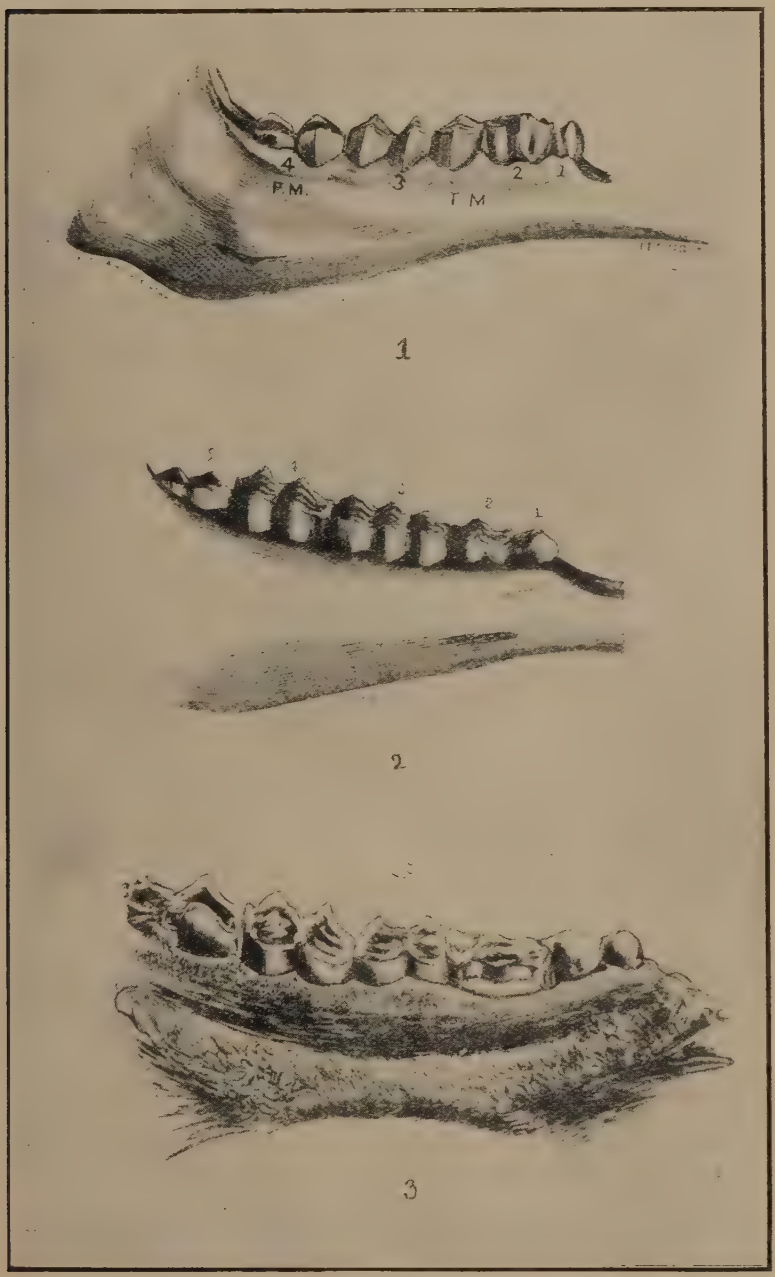
The teeth develop in two lots; the first set is temporary and consists of eight incisors and three molars on each side of both jaws, all of which are up by the time the animal is two months old. At from twelve to fifteen months onwards these teeth are gradually replaced by corresponding permanent ones.

At birth a lamb possesses two temporary central incisors, and at the end of four weeks all the eight temporary incisors are up with usually three molars in each of the upper and lower jaws (first, second and third temporary molars); at three months the fourth, and permanent, molar is cut; at nine months the fifth, also permanent, molar makes its appearance; and at eighteen months the first and second temporary have been pushed out by the corresponding permanent molars, the third is covered by the third permanent, and the sixth permanent molar is cut. Thus a sheep has all its permanent molars up at from eighteen months to two years.

With the incisors, the first two, or central permanent teeth, make their appearance at from twelve months in early to fifteen months in late dentition.



Dentition—Incisors.



Dentition—Molars.

1. Molars at 3 months. 2. Molars at 9 months. 3. Molars at 2 years.

The sheep is then known as a "two-tooth" or "hogget." At two years of age the two teeth on either side of the central teeth are replaced by two permanent teeth. The sheep now becomes a "four-tooth." At three years of age the two third permanent teeth replace the corresponding temporary ones and the sheep is said to be a "six-tooth." At four years the last two permanent incisors appear, and the sheep is then an "eight-tooth" or "full-mouthed."

From this time onwards the age of a sheep cannot be accurately determined by the teeth. From about five years onwards the central teeth will show signs of separating in the middle, and as the sheep ages, other teeth will separate and may be broken. With age, the teeth become worn down or lost and the sheep is then known as "broken-mouthed." In the case of broken teeth it is wise, if only three or four or fewer teeth remain, to pull them out and leave the animal "gummy." A sheep cannot bite with odd or gapped teeth as well as it can with the gums.

Sheep have been known to retain good teeth until an old age. The wear of the teeth, like their development, depends on the class of country, climatic conditions, the early or late maturity of the breed, and whether the mouth is defective or of good shape.

Old sheep should not be purchased or pastured when younger ones are procurable. Further indications of old age are sagging of the loins, distended nostrils, and deterioration of the fleece in quality and quantity.

OBITUARY.

The late W. T. Richardson.

Since the publication of our last issue the "Journal" has suffered a sad loss in the decease of our esteemed colleague and contributor, the late Mr. W. T. Richardson, Poultry Adviser to the Department of Agriculture. He was a personality of wide and varied experience, genial, courteous, and highly respected by all with whom he came in contact, and his helpful advice and instructive articles appearing in these pages from time to time were a source of great interest to those engaged in the poultry farming industry.

Born at Barcelona (Spain) on 3rd June, 1874, his business training began in England in connection with the overseas departments of several big mercantile houses. Later in life he adopted Western Australia as his home, and engaged himself in the pastoral industry of the North-West, being at times musterer, boundary rider, horse-breaker, and eventually manager of stations there. It was at Kalgoorlie he first took up poultry farming, and established what was then the largest farm of its kind in the State. Transferring his activities to Canning, the late Mr. Richardson received his appointment to the Department of Agriculture in October, 1926, and his property was converted by him into an experimental farm for the benefit of the industry.

During the great War, Mr. Richardson joined up with the 10th Light Horse, and saw service in Egypt, Palestine, and Jerusalem, right through the Sinai campaign. He was an exemplary citizen, and with all his varied experiences he preserved a quiet, unassuming manner that made him a popular favourite.

PRODUCERS' MARKETS CO-OPERATIVE, LIMITED.

QUARTERLY REPORT FOR PERIOD ENDING 15th NOVEMBER 1931.

Fruit: Supplies of fruit at the beginning of the quarter were only moderate, consisting mostly of citrus fruit.

Values for Navels were only fair; heavy supplies of falls and inferior fruit being marketed. Lemons were particularly dull, there being no demand whatever during the quarter. Valencias were also marketed during the first of the quarter, but were of poor colour, and met with very little support.

Apples of small grades were plentiful and values low. Toward the end of the quarter, with weather conditions improving, values also improved and many early varieties of fruit made their appearance.

Local Tomatoes touched the exceptionally high price of 45s. per ¾ bushel, while Strawberries, Cherries and early Apricots and Peaches were supplied. With the exception of Granny Smith, apple values continue at low rates, only very slight impovement throughout.

Vegetables: Supplies of vegetables have been good. Potatoes were in good demand and values moderate. Main crops are not yet on the market, but indications are that values will be considerably better than last year. Pumpkin supplies shortened and values for prime lines increased. Swedes were plentiful and values in the main were low. An odd line of choice stuff would command higher rates. Cabbage was steady in supply and value. Cauliflowers were plentiful early in the period and the demand good, values being high for prime lines. During the last month, however, supplies ceased. Peas were heavily supplied from the Metropolitan area, and values were at glut level. French beans and Runner beans are forward now in fair quantities and the demand good. Rhubarb supplies were plentiful and values good throughout. Bunch lines, heavily supplied, and all lines except turnips, sold to a good demand. Lettuce of good quality in good demand all through the period.

Eggs: During the quarter under review heavy supplies came forward both from the metropolitan and country districts, with the result that the demand was not equal to the supply and prices eased. To relieve the market, growers continued to export every available egg, and by so doing kept prices reasonably firm, ranging from 7½d. to 9½d. As the egg industry was passing through its "peak" period supplies showed a further increase, and as a consequence prices dropped to 6½d. for Metropolitan new laid. This drop, together with the favourable exchange position with regard to export had the desired effect of making growers realise their responsibility to the egg industry, and the additional quantities packed for export again firmed, the market leaving it now firm at prices ranging from 8d. to 10½d. During this period we, as export agents for the Westralian Farmers, Ltd., Fremantle, accepted large quantities for export at an advance of 7d. per dozen.

Poultry: Supplies from the middle of August to the second week in October (Show Week) were heavy, with keen competition and good prices for all prime lines. Turkey gobblers and turkey hens were heavily supplied and, considering bad times, realised good values. Gobblers up to 24s. and turkey hens 13s 9d. a

pair Muscovy ducks and drakes also sold well at values up to 7s. 6d. and 13s. respectively. Prime cockerels were in demand at prices up to 10s. 6d. a pair. Inferior lines were hard to quit. After Show week up till the first week in November supplies were light with the quality poor throughout—too many aged and half-grown birds being marketed. The quality of the birds was not up to the requirements of the trade. Turkeys, Muscovy ducks and drakes have been short supplied with good inquiries and values for prime quality. During the past week supplies have improved both in quality and number and promise to continue from now on until Christmas.

Carcase Meat: Pork, veal, and beef short supplied with good inquiries for prime carcases. Lamb and mutton during August were heavily supplied with good prices realising for prime lines and poor quality hard to quit. In the early part of September supplies were short and sold well to a keen demand. The firmness of the market was instrumental in making producers forward larger consignments with the effect of again weakening the market. From the middle of September till now supplies have varied. Apparently consignors studied the market and consigned when the time was most opportune for good values. Throughout the quarter under review pork, veal, and beef have maintained their values, but lamb and mutton values varied from sale to sale in accordance with quantities consigned.

LIVE STOCK AND MEAT.

For the information of readers of this "Journal," the following particulars have been supplied by Messrs. Elder, Smith, & Co., Ltd., Perth:—

COMPARATIVE NUMBERS OF STOCK SOLD AT METROPOLITAN MARKETS.
FOR MONTHS OF SEPTEMBER, OCTOBER AND NOVEMBER, 1931.

	SEPTEMBER.				OCTOBER.					NOVEMBER.			
	2.	9.	16.	23.	30.	6.	14.	21.	28.	4.	11.	18.	25.
Sheep	14,537	11,191	10,573	15,017	20,270	11,250	17,977	22,253	19,782	19,754	9,669	14,974	10,763
Cattle	491	390	418	394	371	539	546	510	434	478	455	700	511
Pigs	1,495	1,327	1,296	1,303	1,503	732	1,665	1,253	2,110	1,302	1,410	1,326	1,297

COMPARATIVE VALUES PER POUND.

Mutton	4¼d.	4½d.	3½d.	3½d.	3d.	3d.	3d.	2¾d.	2½d.	2½d.	2½d.	2½d.	2½d.
Beef	5d.	5d.	5d.	5d.	5d.	4½d.	4½d.	4d.	4d.	3½d.	4d.	3¾d.	3½d.
Pork	6¾d.	6¾d.	6½d.	6½d.	6½d.	6½d.	6d.	6d.	6d.	5½d.	5½d.	5½d.	5½d.
Bacon	5d.	5¼d.	5¼d.	5¼d.	5¼d.	5¼d.	5¼d.	5¼d.	5½d.	5½d.	5¼d.	5¼d.	5¼d.

METEOROLOGICAL INFORMATION.

Stations.	Temperature.				Rainfall.		Temperature.				Rainfall.		Temperature.				Rainfall.	
	Maximum.		Minimum.		For Month.	Average.	Maximum.		Minimum.		For Month.	Average.	Maximum.		Minimum.		For Month.	Average.
	Mean.	Highest.	Mean.	Lowest.			Mean.	Highest.	Mean.	Lowest.			Mean.	Highest.	Mean.	Lowest.		
	SEPTEMBER.						OCTOBER.						NOVEMBER.					
					inches.	inches.					inches.	inches.					inches.	inches.
Chapman State Farm	67·8	75·2	45·4	40·0	2·00	1·62	78·7	94·8	50·9	41·1	0·96	0·96	85·5	100·7	58·1	47·1	1·25	0·29
Geraldton	68·3	77·0	53·2	45·0	2·33	1·36	76·3	91·0	53·2	46·0	0·47	0·71	82·2	98·4	60·5	50·4	0·18	0·26
Walebing	64·5	75·2	43·5	33·2	2·70	2·18	75·1	96·7	48·4	38·0	0·69	1·35	83·0	98·8	53·2	41·2	0·10	0·54
Perth	63·8	69·6	50·5	40·6	5·27	3·46	72·8	91·6	53·7	40·0	1·01	2·19	79·2	94·6	57·1	46·2	0·03	0·80
Kalamunda	60·7	66·2	46·8	37·3	7·52	4·69	70·8	93·5	51·5	38·5	1·70	3·15	78·8	92·6	52·6	44·1	0·02	1·07
Bunbury	62·2	68·0	49·2	38·0	3·91	3·69	68·0	81·0	48·0	38·0	1·65	2·43	74·8	85·0	52·8	44·0	0·05	1·02
Bridgetown	60·9	69·5	43·5	31·5	5·84	3·96	72·9	89·0	42·4	31·0	2·03	3·02	81·3	98·0	47·5	37·8	0·41	1·15
Albany	62·2	73·4	47·6	39·0	7·10	4·13	66·6	91·2	50·0	43·8	2·73	3·21	67·3	92·0	54·9	50·0	0·93	1·44
Merredin State Farm	65·7	89·4	40·7	32·9	0·81	1·14	75·4	95·7	48·4	32·3	0·44	0·84	79·8	96·8	52·1	40·9	0·24	0·44
Northam	65·2	77·0	44·9	35·0	2·73	1·62	75·8	97·0	48·4	35·0	0·94	0·99	82·3	98·0	53·4	44·0	0·13	0·39
York	64·8	79·0	43·8	33·0	2·95	1·60	74·9	94·0	47·0	37·5	0·30	1·03	81·1	98·2	51·3	42·5	0·24	0·43
Narrogin State Farm	61·9	77·8	42·2	33·0	3·97	2·21	71·9	88·0	44·0	30·0	0·72	1·40	77·9	96·0	47·2	37·2	0·24	0·56
Katanning	61·0	73·0	44·6	36·7	3·62	1·94	71·2	88·6	44·5	34·3	0·65	1·56	76·9	96·7	49·0	39·8	0·17	0·68
Cape Leeuwin ...	60·6	64·5	56·8	48·0	5·75	3·42	64·6	84·0	53·9	44·5	2·66	2·91	68·2	85·2	57·1	53·0	0·36	1·25

WESTERN AUSTRALIA—DEPARTMENT OF AGRICULTURE.

LIST OF BULLETINS AVAILABLE FOR DISTRIBUTION.

No. 20.—*The Pruning of Fruit Trees.* J. F. Moody. Price 2s. 6d.
No. 24.—*Hints to Stock Breeders* (revised). R. E. Weir.
No. 37.—*Conference of Producers,* 1910 *and* 1912.
No. 46.—*Fruit Packing and Marketing and Exporting of Fruit.* J. F. Moody and J. Ramage. Price 1s. 6d.
No. 49.—*The Feeding of Horses.* Professor Paterson and G. L. Sutton.
No. 57.—*Vermin Destruction.* A. Crawford.
No. 60.—*The Farmer's Clip.* J. J. Mahood.
No. 68.—*Flaying and Treatment of Hides.* R. E. Weir.
No. 74.—*Tobacco Cultivation.* A. R. C. Clifton.
No. 79.—*Sheep on the Wheat Farm and their Management in W.A.* H. McCallum.
No. 83.—*Horticulture and Viticulture.* A. Despeissis. Price 2s.
No. 88.—*Light Land: Conference.* G. L. Sutton.
No. 90.—*Stock Waters: Standard for Composition of.* E. A. Mann.
No. 91.—*Dairy Premises.* P. G. Hampshire.
No. 93.—*The Home Tanning of Sheep and other Skins.* H. Salt.
No. 96.—*Poison Plants of W.A.* D. A. Herbert.
No. 99.—*Australian White.* G. L. Sutton.
No. 101.—*Cotton Cultivation.* G. L. Sutton.
No. 103.—*Kerosene Method for Eradicating Zamia Palm.* G. K. Baron-Hay.
No. 105.—*Pedigree Selection of Seed.* G. L. Sutton.
No. 106.—*The Red Legged Velvet Earth Mite.* L. J. Newman.
No. 112.—*Automatic Device for Eradication of Stickfast Flea.* G. Allman.
No. 113.—*Picked Pieces: Classification of Clip.*
No. 114.—*Blue Mould on Citrus Fruits.* W. M. Carne.
No. 115.—*The Value of Windmills for Pumping Water in W.A.* A. H. Scott.
No. 117.—*Cream.* P. G. Hampshire.
No. 149.—*Lucerne.* G. L. Sutton.
No. 192.—*Root Rot.* A. J. Despeissis.
No. 220.—*Irrigation and Drainage.* A. H. Scott.
No. 221.—*Soudan Grass.* G. L. Sutton.
No. 225.—*Subterranean Clover.* G. K. Baron-Hay.
No. 238.—*The first Australian Studmaster—His Flock.* G. L. Sutton. (Reprint from "Journal.")
No. 239.—*Field Experiments, Chapman.* I. Thomas (Reprint from "Journal.")
No. 241.—*Field Experiments, Merredin.* Langfield (Reprint from "Journal.")
No. 242.—*Field Experiments, Avondale.* Wild and Bailey. (Reprint from "Journal.")
No. 243.—*Successful Codlin Moth Control in W.A.* G. W. Wickens. (Reprint from "Journal.")
No. 245.—*Leaf Rust of Stone Fruit.* W. M. Carne. (Reprint from "Journal.")
No. 246.—*Field Experiments—Wongan Farm.* I. Thomas. (Reprint from "Journal.")
No. 249.—*Phosphate or Phosphoric Acid.* G. L. Sutton. (Reprint from "Journal.")
No. 250.—*Sheep—Hand-feeding.* H. McCallum. (Reprint from "Journal.")
No. 251.—*Rutherglen Bug.* J. L. Newman. (Reprint from "Journal.")
No. 252.—*Worms affecting Sheep.* H. W. Bennetts. (Reprint from "Journal.")
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No. 289.—*The Unsound Economics of the F.A.Q. Standard for Selling Australian Wheat.* Geo. L. Sutton.
No. 290.—*Wax Scale* (*Ceroplastes Ceriferus*), Anderson. L. J. Newman, F.E.S., Entomologist; B. A. O'Connor, B.Sc. Agr., Agricultural Adviser; and H. G. Andrewartha, B.Sc.Agr., Agricultural Adviser.
No. 291.—"*Early Blight*" or "*Leaf Spot*" and the *Macrosporium* "*Storage Disease*" of *Potatoes.* H. A. Pittman, B.Sc.Agr., Plant Pathologist.
No. 292.—*Cultivation of Onions.* E. T. Morgan, Vegetable Inspector.
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No. 316.—*Bananas.* F. J. S. Wise.
No. 317.—*Blowflies in South-West—Seasonal Influence.* Newman, O'Connor and Andrewartha.
No. 318.—*Bees Act.* Willoughby Lance
No. 319.—*Cape Gooseberry.* G. W. Wickens.
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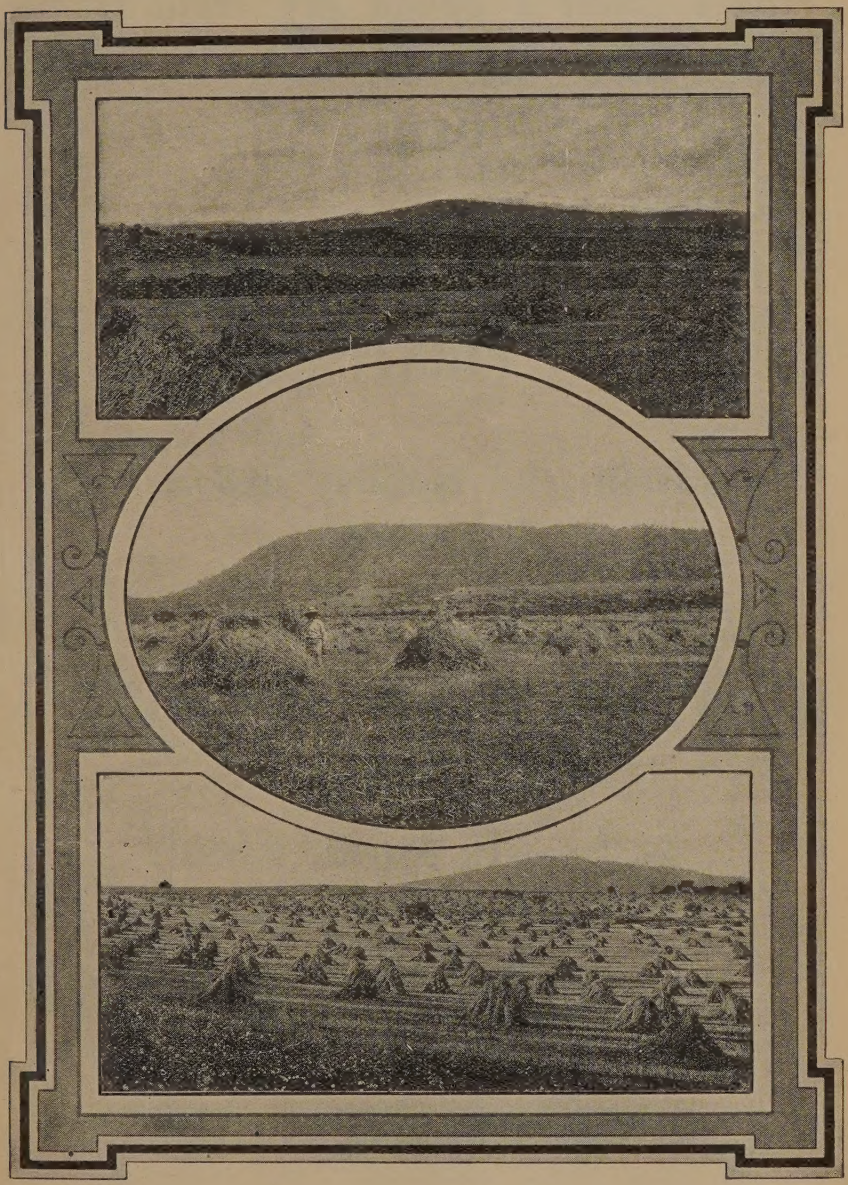

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